FARM PROJECTS

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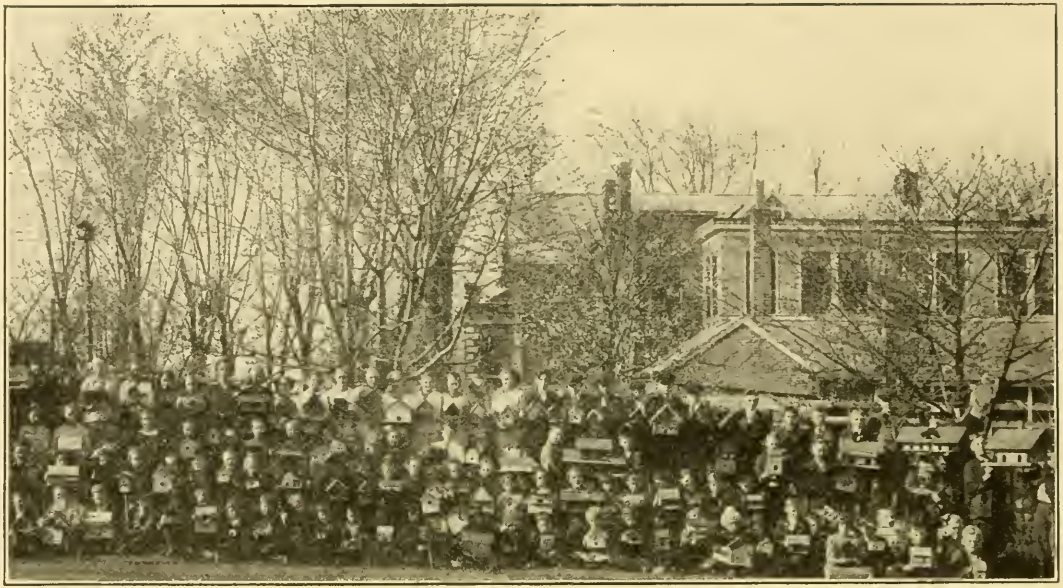
FARM PROJECTS



Courtesy of the Bird Club, Waterloo, Ill.

WHAT A GROUP OF SCHOOL BOYS AND GIRLS CAN DO TO ATTRACT AND PROTECT THE BIRDS

FARM PROJECTS

A TEXTBOOK IN AGRICULTURE

FOR

SEVENTH AND EIGHTH GRADES

AND

JUNIOR HIGH SCHOOLS

BY

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THIS BOOK IS DEDICATED TO OUR FORMER
TEACHER AND COLLEAGUE

PROFESSOR W. W. CHARTERS

NOTE TO TEACHERS

Many teachers, in beginning a course, consider that the effectiveness of the whole course depends on their following, chapter by chapter, the material as outlined in the book. The effectiveness of this course in agriculture depends, rather, on the teacher's willingness and ability to adapt the material to the community's needs. There can be no better way to introduce the course than to spend probably a week's time on the "Introduction," giving the pupils all the time and opportunity they desire to suggest topics and plans for further study.

It is essential that the pupils start the work with the point of view that what they do in school is an extension of their home activities and that by applying themselves to work in school they will make their home tasks easier and more productive. Make them see the dollars and cents value of their work.

The course in agriculture may be begun at a time of year when the projects suggested in the first part of this book are not feasible. In that case, make the book fit the season.

A criticism often aimed at the project method is that after the pupils have carried the project to completion, no time is devoted to drill on principles and information

introduced during the process of solving the problem. Make sure, therefore, that the principles involved in this course in agriculture are illustrated and drilled upon. After the pupils have finished their course they should not only be trained in farm activities but they should have a knowledge of the general principles underlying these activities.

Anticipate your projects. It may be that a certain project should be started four or five weeks before the problem is taken up as one of the main divisions of the course. Best results will be obtained if after you have studied the projects suggested, ascertained the local agricultural problems, and considered the time of year in which the work is to be started, you will make a chart of the projects to be undertaken. You may be able to plan new and interesting projects to be worked out in connection with the course as outlined in the text.

There can be no question that the interest and enthusiasm of the pupils will be aroused if the school work in agriculture is shown to be directly concerned with the problems arising on their home farms.

C. C.
J. A. S.

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FARM PROJECTS

I

INTRODUCTION

Have you ever won a blue ribbon for a fine hog at your County or State Fair? Have you ever taken first prize for the best ears of corn at your corn show? If you read the newspapers, you have read about a number of boys who have brought home many prizes for their exhibits at the State and County Fairs. What is more to the point, there is no reason why your exhibits shouldn't be just as fine as theirs, if you will enter into the spirit of the work as it is suggested in the following pages.

In starting this work, you are starting something just a little different from anything you have ever undertaken in school before. If you have helped your father on the farm, you know of the many things he must know and plan to do. It may seem strange to you, at first, to find that these are the very things which are to be taught in this course and that you will be able to help him by actually doing some of his work while you are at school. You also know of a number of things which you yourself like to do about the farm. Aren't

you surprised to find that these are the very things which are to be studied about in this book?

When you go home to-night, sit down with your father and mother and ask them to tell you about their plans for managing your farm. Is the major crop to be corn or wheat? Does your father expect to devote most of his energies to the raising of high-grade stock? Does he expect to test his seed corn? Does your mother find the raising of a few chickens profitable? Are there any improvements to be made or is there any new machinery which is to be bought?

What you learn in studying each topic will be of immediate help to your father and may help him to save a large amount of money. You will read about a boy who started a friendly contest with his father in raising pigs. By the time the litters were four weeks old, the boy's pigs, which had been fed according to the method which he learned in school, were much finer than his father's. The father was so much pleased with his son's success that he gave him one litter of pigs and started a bank account for him for the purpose of paying his expenses through high school and, later, through the agricultural college.

If you will explain to your father what you are doing, he may be induced to give you a pig or a few chickens or may let you have some land on which to raise some kind of crop. By a little thoughtful planning, you can raise large quantities of vegetables in a comparatively small space. When you try exper-

iments at home, it will be interesting for you to compare results with boys who are using the same methods that you are and with those who are using different methods.

In your school you may not take up the work in the order suggested here, since you may have other problems to consider, but after you have read over the list of topics you can talk the matter over among yourselves and decide on the order which will be of most help to you in your work. Perhaps you can make a report to your teacher on the topics you would like to study first.

It may be that you will find some difficult problems to work out at the very beginning. We usually find it easier, however, to do things which are considered hard, when we have a real reason for doing them, than to do "easy" things when we see no reason for doing them.

You will see clearly why we must plan for a considerable amount of home work. What we learn in school, however, would not have much value unless we could use it at home, would it?

Anything of interest about the farm may be part of this course in agriculture. Not all the subjects on which a first-class farmer should have some knowledge can be discussed at length in school, but most of them will be given some consideration.

It will probably be wise to begin your work by making a community map like that suggested in the following chapter, in order that you may know the "lay-out" of the farms in the community in which you live.

II

THE COMMUNITY MAP

Class Exercise

All boys and girls who are studying about farms and farm life should know something about the farms of the community in which they live. It would be a waste of time to spend several years at school studying agriculture if, at the end of that time, we knew nothing about the farms in our own section of the country. In studying the various topics included in this book, then, we must be sure to know how the information we gain applies to our own community. If we are studying wheat, we must know what kinds of wheat are grown on the farms around us and the methods employed by the farmers who raise the largest crops. If we are studying trees, we should know what trees grow in our own orchards and wood lots and how these are cared for.

Of course, most boys and girls have some knowledge of what kinds of live stock and what crops are raised in their community. But if we make a systematic study of this community, we shall discover many interesting and valuable facts which are not generally known. We must try to observe something new each

day; for our experiences will be a valuable part of the lessons taught in school.

When we study about a new country in geography we usually find a map of that country at the beginning of the lesson. Maps record many items which would be difficult to explain clearly in a written account. Ideas of proportion in size, quantity, and distance, can be better illustrated by a map. As we have no map which contains the information about our community that we want, we shall have to make our own map.

Obtain from the stationer's or the print shop several sheets of heavy paper, thirty inches by thirty-six inches, suitable for map making. Decide upon a convenient scale for the map, one inch to twenty-five rods being a convenient scale for such maps. A preliminary sketch may be made upon the blackboard. Include in the map all areas that are represented in the school community or district. If the area to be included is too large to be shown clearly on one map, sectional maps may be made and fitted together. Divide the area into four equal parts and draw the maps on four sheets of paper so they may be fitted together and made to match. When the boundary lines of the whole area have been carefully drawn, the following items should be indicated in the order named:

1. *Roads.* All crossroads and main highways should be indicated by red lines on the map.

2. *Boundary lines of the farms.* Accurate data should be obtained by members of the class showing the size of each farm.

The value of this map as it is used through the year will depend largely upon the accuracy and neatness exercised in placing the boundary lines.

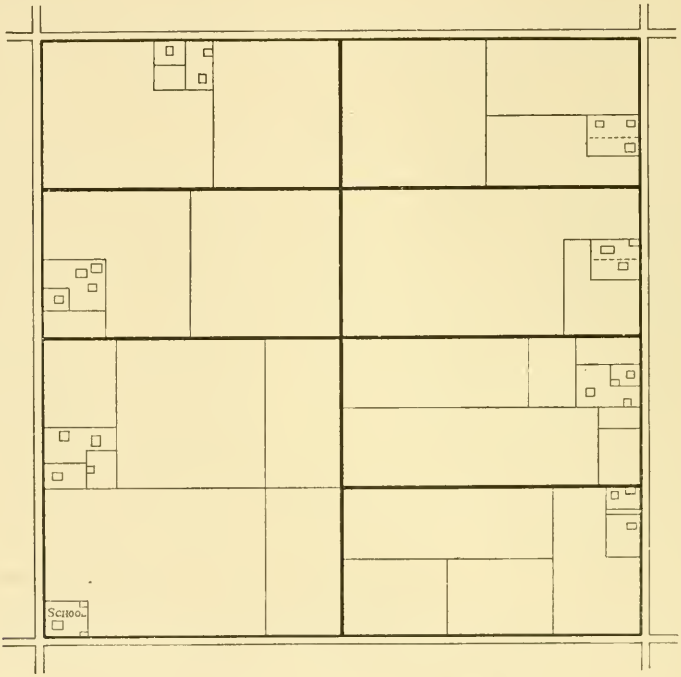


Fig. 1. Outline map of one quarter of a school district showing farms and fences

3. *Streams.* Locate the source of each stream and drainage ditch cutting through the farms, using blue lines.

4. *Forest areas.* Shade in black all areas that are forest lands and non-tillable.

5. *Fields.* The farms should be divided into fields as they are fenced off, or divided by the farmers. Each member of the class

should bring a map of his father's farm, showing the division fences. The data from farms not represented in class may be obtained by members of the class who live near by.

6. *Farm buildings.* The farm houses, barns, and other buildings may be located on the map after the division lines are placed in each farm.

7. *Public property.* Locate the school grounds and school houses, and other public property.

The illustration, Fig. 1, shows an outline map which follows the above suggestions. It represents one quarter of a rural school community.

Each member of the class should draw a map in his notebook exactly like the large map, except in size. One inch to one hundred sixty rods is a convenient scale.

If there is a hectograph or mimeograph in the school, several copies of the smaller maps should be made for the use of the class in representing crop areas and other interesting data. Parents will be glad to see these maps. The small maps may be shaded in various ways to show the clover fields, the wheat fields, the cotton fields, and the portion of any section devoted to a certain crop.

Problems and Review Exercises

1. How many acres are there in a section?
2. How many rods square is a quarter section?
3. How long is an eighty-acre field which is forty rods wide?
4. If a field is ten rods wide, twenty rods long on one side, and twenty-six rods on the other, how many acres are there in it?

5. How many farms are there in the school community? What is the average size of the farms? How many acres are there in the smallest farm? In the largest farm?

6. How many miles of fence are there in the school community? Estimate the amount of money invested in fence.

7. How wide are the roads in the community? What per cent of the land is used for public roads?

8. What per cent of the total acreage is devoted to corn? To wheat? To orchards? To pasture? Is this distribution economical? Does this distribution bring the best returns?

9. How many acres of land on your farm are not tillable? What is the reason? How much is taken up by the barnyard and other yards, including space for buildings?

III

PLANTS

Home Work

In order to see clearly the relation of the different parts of a plant to each other we shall study the plant as a whole. The potato is a good example to use if it is growing at the time this project is studied, but if not, some other plant which is growing in the garden may serve.

The entire plant should be taken from the soil and the soil washed from around its roots. Measure each stem and each root in order to find out the total length of the stems and of the roots. Compare the length of the roots with that of the stems. Count the number of leaves on the plant. Are there any other structures which are not true roots, stems, or leaves? If so, where are they located? Make a drawing of the plant showing all the parts. Notice the root hairs near the tip of the root. Compare the fleshy part of the sweet potato with the fleshy part of the Irish potato. Does the sweet potato have eyes similar to the Irish potato? Are the sweet potatoes cut into parts when planted? Write the history of a potato plant from the time it is planted until it is taken out of the ground for use

as food. Answer the following questions from your observations:

1. How many leaves are there on an ordinary Irish potato plant? Estimate the total number of square inches of leaf surface.

2. What happens if a part of the root system of a plant is destroyed by cutting off the roots with a spade?

3. Which yielded the larger income last year on your farm, the animals and animal products or the plants and their products?

4. Make a list of all the plants you can find on the way to school.*

5. What wild plants in your locality are of some value as food for people or can be used to feed animals?

Facts to Be Studied

Extent of Plant Growth.—Almost everywhere on the face of the earth we find plants growing. Plants are living things just as animals are, and are able to adapt themselves to varying conditions. Even the most rocky portions of the earth are covered with kinds of small plants, such as mosses, lichens, and small shrubs. Tiny plants may be found growing up through the snow on the mountains, bearing flowers though the snow covers the ground most of the year. Even on the deserts plants may be found which are adapted to the hot dry climate there. Some classes of plants are so small that they cannot be seen without the aid of a high power microscope. The bacteria illustrate this class. These plants are sometimes, though

* This may be made a class contest.

incorrectly, called germs; they cause disease when they get into the blood, cause decay, cause milk to sour, and produce many other results which are apparent in everyday life. Some small plants such as water lilies grow in water. The scum which is sometimes found on the surface of ponds is really made up of growing plants.

Uses of Plants.—We are more interested, however, in the group of plants called seed plants, because this group has a greater economic value. The botanist calls this group spermatophytes, the word meaning seed-bearing plants.

Plants furnish the basis for all animal life and if it were not for plants, animals could not live. Plants furnish food, shelter, and clothing for man. The food plants are so numerous and so widely distributed that we need not list them here. Our houses are built of the wood from trees. Thus we obtain shelter for ourselves and for animals. The cotton plant is a worthy rival of the wool-producing sheep in the business of producing material for our clothing and house furnishings.

Plants are also used very extensively for medicinal purposes. The Indians early recognized this value of herbs. We have developed the industry until we are able to extract quantities of drugs and chemicals from plants.

The Plant as a Factory.—As our existence from year to year depends upon the growth of plants, we should

give some attention to the growth of useful or economic plants, our purpose being to learn how to grow better plants. We may best begin by studying a single plant to learn how it grows. Every plant may be considered as a factory which takes raw material from the soil and from the air and works it over into finished products. The apple tree, through its roots, takes the mineral matter and water from the soil, and through its leaves takes carbon dioxide from the air. These materials are changed and worked over in the cells of the leaves and stems, and a part of the material thus worked over goes to make up the apple, which we use as food.

We should remember that the apple tree does not manufacture apples for us to eat, but produces apples because that is the method of forming and preserving the seed that is to produce another apple tree. If allowed to grow undisturbed by man, the apple tree would not produce such delicious fruit because fine fruit is not necessary for the purpose of reproducing a tree. When we eat the potato, the apple, or the grain of wheat or corn we are eating that which nature intended to produce new plants.

Parts of the Plant.—This plant factory is so made that no man has ever been able to imitate it. We find that a plant is divided into such main parts as the roots, stems, leaves, flowers, and fruits, all parts being put together in such a way that they work in perfect harmony for the single purpose of producing another

generation of plants. The individual plant uses great quantities of water, just as the steam engine uses large quantities of water.

The function of the roots of plants is:

1. To hold the plant in its place in the soil.
2. To furnish a channel through which the sap is transferred from the roots to the leaves.
3. To furnish a storehouse for the finished product.
4. To act as a workroom of the factory.

The function of the stem is:

1. To hold the leaves up to the light.
2. To furnish a channel through which the sap is transferred from the roots to the leaves.
3. To furnish a storehouse for the finished product.
4. To act as a workroom in some cases for the factory.

The function of the leaves on the plant is:

1. To manufacture starch or food.
2. To provide an exit for water and an entrance for carbon dioxide. (Water is given off and carbon dioxide breathed in through the leaves.)

The leaf also acts as a storehouse for food in some plants. In each leaf of the plant there is a greenish substance called *chlorophyll* which helps to supply food to the plant by turning the carbon dioxide into food which the plant needs.

The function of the flower of the plant is to make preparation for the production of the fruit; that is to say, the flower is the undeveloped fruit of the plant and the purpose of the fruit is the reproduction of the plant.

If we study the root structure we shall find that the root is covered near its tip with very fine hairs. These root hairs, as they are called, are really only extensions on the outside wall of the cells of the plant.

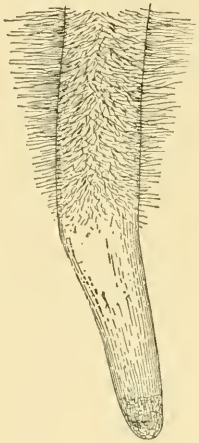


Fig. 2. Root tip and root hairs

The sap in the plant is thicker than the moisture in the soil and this moisture flows into the plant, and is taken up through the channels of the root and stem. As soon as the water has entered the root it finds its way through the channels of the root and through the stem to the leaf. If a cross section of a piece of stem be examined, these channels in the coarse structure of the wood may be easily noted.

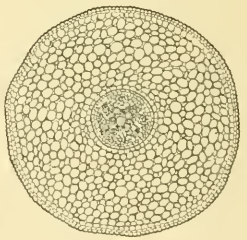


Fig. 3. Cross section of young root showing cell arrangement

How the Starch Is Made.—In the stem are tube-like cells through which the water passes to and from the leaf. The water which thus enters the plant, carries with it a mineral food in solution from the soil and it is in this way that the food reaches the various parts of the plant where it is worked over into the plant tissue. Starch is composed of three elements, viz., hydrogen, oxygen, and carbon, two of which (hydrogen and oxygen) make up what is commonly known as

water. Two of them, carbon and oxygen, make up carbon dioxide. The leaves breathe in the carbon dioxide and obtain water from the soil and, in the various channels composing the body of the leaf, these two substances are worked over into a single substance called starch.

Power of the Factory.—If we were to analyze this starch in the chemical laboratory we should find that it contained carbon, hydrogen, and oxygen. The oxygen which is not used by the plant is given off into the air, and all day long this little factory keeps working away making starch from these two raw materials, water and carbon dioxide. It is truly a factory, but from what source does it derive its power? What and where is the little engine that makes the factory go? The sun is the engine, giving the plant all its energy by means of the sunlight. The plant ceases to make starch in the dark. Most plants do the manufacturing during the daytime and then store the food away at night. The starch is transferred to some other part of the plant, for instance to the roots to be stored, or it may be taken to some part to be further worked over into other kinds of food.

For the purpose of building up plant tissues and producing fruit, plants require ten elements, which they get from the soil, air, and water. These elements are carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, iron, and magnesium. An easy way to remember these elements which the plant

requires to make its growth is to memorize the following expression: C. Hopk'ns CaFe, Mg. The first letters of each of the elements are used in the expression; thus, C—Carbon; H—Hydrogen; O—Oxygen; P—Phosphorus; K—Kalium, the Latin word for potassium; N—Nitrogen; S—Sulphur; Ca—Calcium; Fe—Ferrum, the Latin word for iron; and Mg—Magnesium. If one of these elements is lacking in the soil, the plant is sure to die and if one is present only in a small amount, the plant's growth will be retarded. If a barrel is made of long and short staves it will hold water only to the top of the shortest stave. Just so, the plant can grow only until the most limited element in the soil is all used; then it must cease growing no matter how large a quantity of the other elements is in the soil.

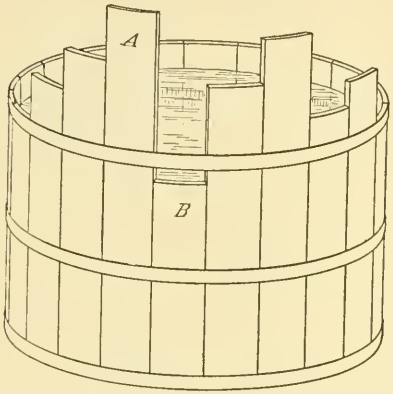


FIG. 4. THE AMOUNT OF WATER WHICH THE BARREL WILL HOLD IS LIMITED BY THE LENGTH OF B.

The Potato as an Illustration of Plants.—To illustrate the different parts of this factory we have been talking about we may study the potato plant. The roots of the plant extend several inches in all directions from the center of growth, and it is through these roots that the mineral food and water enter the plant. The

green stem of the plant, in this case extending above the ground, not only supports the leaves but also furnishes a channel for transporting the sap from the roots to the leaves. It is in the leaves that the starch is made. The starch being made in the leaves, is transferred into the little storehouses through the channels of the stem. These storehouses are called tubers. It may seem that these tubers are the roots of the plant, but this is not the case, as they are attached to the little stemlike structures which are beneath the soil. They are the storehouses of the plant in which the finished product is stored. The flower of the potato appears above ground and grows on the stem much the same as the flower on the apple tree grows. In some instances the seed develops just as it develops in the apple and this results in a structure which is called the fruit of the potato. While it is true that the potato is grown from the tuber which has a number of eyes, or buds, which are to produce other plants, it is also true that new plants may be obtained from seed. Every new variety of potato must be started by seed.

The Irish potato plant illustrates the structure of most of the plants we have mentioned so far. The sweet potato stores its food in a different way, storing the starchy food in its roots which become fleshy at one point rather than in the stems. An example of a plant which stores its food in the stem above the ground is the kohlrabi which produces an enlargement of the stem just above the ground. A plant which stores its

food in the main stem is the beet or radish, while the cabbage stores its food in the leaves, which taken together are called a head. We use these parts of the plant which we have called storehouses for food when we eat the tubers of the Irish potato, the fleshy roots of the sweet potato, and the heads of the cabbage.

Problems and Review Exercises

1. How is plant growth related to the richness or fertility of the soil?
2. Name all the uses of plants which you can illustrate.
3. In what ways is the plant like a factory?
4. Why does the corn plant produce seed?
5. Name the main parts of a plant and give the purpose of each part.
6. How is moisture taken into the plants?
7. Where is starch made? How?
8. What is the source of power for the manufacture of food in the plant?
9. Name the elements required for plant growth. Define the word element. (Consult the dictionary for the meaning of the word element.)
10. What is meant by a plant's storehouse?
11. Give examples of plants which store food in the leaves; in roots; stems; underground stems.

IV

PLANT PROPAGATION

Home Work

Place some bean seed between pieces of blotting paper on a plate. Keep in a warm place and apply plenty of moisture to keep the blotter from becoming dry. The moisture will not evaporate rapidly if two dinner plates are used, one turned over the other.

Place some seeds on another plate and keep them covered with water. Note what happens.

Place another plate, containing the seed between the blotters, in the ice box or in some other cold place. What happens? What seems to be necessary for good germination or first growth?

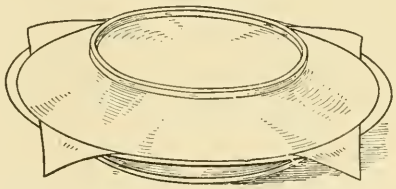


Fig. 5. Seed may be germinated between plates

Test clover seed for vitality by placing one hundred seeds between blotting paper on a plate, keeping the paper moist for a few days. Count the number of seeds which germinate. What per cent germinate?

Make cuttings of some plants at home and start them in pots of sandy soil. Choose the plants which are

most convenient; that is, plants growing around your home. Geranium plants make good cuttings which grow readily when placed in fine soil. The cuttings may be made by cutting off about three inches of the stem or branch and pinching off the leaves. The cuttings may be started in sand or in a glass of water, in which case they should be transplanted as soon as the roots appear.

FIG. 6. BEANS GERMINATING

FACTS TO BE STUDIED

How Plants Are Started.—Crop production depends upon the care of plants, a part of this care being the propagation of plants or starting of plants from time to time. Each season the farmer must plant new crops which means that he must aid the plants in getting a start. The most common method of starting plants for a new crop is that of planting seeds. Some plants begin their new growth by means of spores which are microscopic structures corresponding to the seeds of larger plants. A third method of propagation is that of making cuttings, or using a part of the plant itself other than the seed or spore to start a new growth.

Seed.—The seed of plants is so commonly known that little need be said about it. The seed is really a small living plant imbedded in enough food to keep it grow-

ing until it can manufacture its own. Most economic crops are started by means of seed. Each kind of seed differs from every other kind, though seeds of different plants sometimes resemble each other so closely that it is difficult to distinguish them. The most important problems before the farmer at planting time are to make sure that the seed which he is about to plant is pure and that it will grow. A method of testing seed is outlined in the chapter on "Testing Seed Corn."

Factors Necessary for Germination or Growth.—In order that plants may be grown from seed, certain factors are essential:

1. The seed must be vital; that is, it must be alive and ready to start growth when the conditions are right.

2. Plenty of moisture must be present. Seeds will not germinate without plenty of moisture. If seeds would start growth without moisture, they would grow through the winter while in storage. If the soil is rolled after planting, the moisture rises in the soil more rapidly and the seed is more likely to get enough moisture to start growth than if it is sowed in a rough seed bed.

3. Air is necessary for the first growth of the plants. If seeds are kept under water, they will not germinate, because the water excludes the air. Frequently stands of corn and other crops are poor because the soil has been wet when the seed was planted.

4. Warmth is needed to start the processes of growth. However, some seed germinates at a rather low tempera-

ture. Lettuce and radishes may be planted in the garden very early in the spring and they will germinate and make a good growth despite the cool temperature. On the other hand, corn, beans, and cucumbers require a higher temperature for good germination. It is apparent that the farmer has many problems to face in starting a crop from seed.

Storage of Seed.—The seed must be stored under good conditions, or the tiny embryo or baby plant will be injured, or, in many cases, killed by weather conditions. Seed is usually planted the next year after it is produced, although many kinds of seeds live much longer. Some weed seeds have germinated after twenty-five years, while peas and soy-beans do not germinate well after two years.

Buds.—There are many kinds of buds and many methods of starting plants by bud growth. Some specialized forms of buds are the *bulbs* and *corms*. Examples of *bulbs* are the tulip, onion, and many lilies. The bulbs are really shortened stems containing buds which begin growth, forming a new plant as soon as conditions are right for the growth of the bud. The bulbs are made up of leaves or scales lying close together while the *corms* are solid throughout. The crocus, one of the earliest flowers to bloom in the spring, is propagated from corms.

The *tuber* is another specialized part which produces a new plant from its buds or eyes, the Irish potato being an example. Tubers are underground stems

thickened or fleshy, sometimes thought to be parts of the root system.

Other plants reproduce by means of *rootstocks*, or thickened underground stems producing roots; *runners*, or trailing stems producing new plants from the nodes; or *suckers*, which are plants produced by stems covered with earth. Timothy reproduces by means of rootstocks, strawberries by runners, and raspberries by suckers. Some plants such as the grape are propagated by *layering*. The stems are brought to the ground and covered with soil so as to start new growth from the nodes of the stems. Black raspberries naturally bend to the ground and the tips of the stems take root in the soil, forming new plants.

Cuttings.—Sometimes the farmer cannot depend upon nature to propagate the plants which grow from buds, so he helps her in the work of propagation by making cuttings of stems, roots, or leaves. Every farm boy is familiar with the method of cutting the Irish potato, it being necessary to have an eye in each piece before a new plant can be formed. New plants would be formed if the whole potato was planted, but many more plants may be obtained by making cuttings. The geranium is a good illustration of a plant that is propagated by stem cuttings, it being possible to start large numbers of plants from a single branch of geranium plant. Usually the parts of the stem with growing tips are selected, and cuttings are made from two to six inches in length. When the base of the cutting is buried in warm, moist

soil, growth soon begins and roots are sent out from the stem.

Sometimes leaf cuttings are made from such thick-leafed plants as the begonia. The leaves contain much food and will soon start a growth of roots if they are cut at points along the rib, laid on wet sand, and kept warm and moist for a few days. Root cuttings are made like the stem cuttings. Most plants can be started by making root cuttings if the same conditions for growth are present that were mentioned as requirements for seed germination.

When to Make Cuttings.—The hardwood cuttings, such as the grape, require long periods of time to start new growth and should be made in the fall and stored in moist sand through the winter. When they are placed in the soil in the spring, they will make an early growth. Tuber cuttings are made at planting time, as there is no advantage in making them earlier. Soft wood cuttings such as the geranium may be made in the fall and started in pots in the greenhouse, or the plants may be stored over winter and the cuttings made in the spring.

Problems and Review Exercises

1. List all the plants grown in your community which are propagated by seeds; by spores; by vegetable parts or buds.

2. If in 100 seeds, 95 alfalfa seeds and 5 weed seeds are found, and by testing it is found that 85% of the alfalfa seeds grew, what percentage of the entire sample is good alfalfa?

3. Give reasons for testing seed before planting.

4. Ask your father about the pure seed law in your state. What requirements does the law make?

5. Describe the different kinds of cuttings that may be made.

6. What advantage, if any, would be gained by planting whole potatoes instead of pieces?

7. Make a list of all the plants grown on your farm which are grown from seed but which do not produce seed in your climate. Where is such seed secured?

V

PLANTING THE SCHOOL YARD

School Exercise

Making a Map of the School Grounds.—This exercise can be carried out satisfactorily if all the members of the class will coöperate. You should work together in drawing a map of the school grounds, using some convenient scale, a satisfactory scale for most school grounds being one inch to ten feet. Indicate on the map all trees and shrubs that are already on the grounds. Mark off the ball diamond and other places used for sports and indicate all playground apparatus. Draw in the walks, outline the borders about the school house and the corners of the yard as you think they should be planted, and make a list of the number of trees and shrubs which will be required. See the illustration on the following page for suggestions.

Planting Date.—Planting may be done in the spring or fall but there are some advantages in planting the school yard in the fall, as you can learn how to care for the plants during the fall and winter and again in the spring when they begin to make their growth. You can interest many of the friends of the school in the work which you are doing if you make the planting

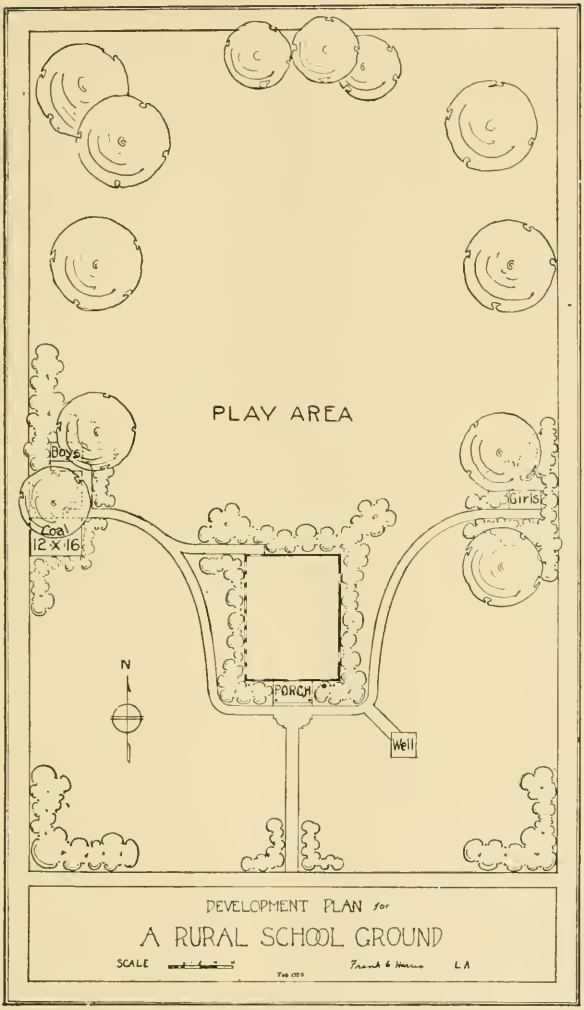


FIG. 7. PLAN SHOWING METHOD OF GROUPING SHRUBS AND TREES

day a "patrons' day" and arrange an appropriate program to be carried out during a part of the day.

Obtaining the Shrubs.—Many shrubs may be obtained from the home yards in the community. Such shrubs as lilac may be found growing in great masses; frequently one clump will furnish enough small shrubs for a school yard, the original clump being better for having been thinned. Spirea, more commonly known as bridal wreath, and honeysuckle are to be found in many yards; both shrubs are very desirable for the school yard. What shrubs are commonly found in your locality? What shrubs can you furnish from your own yard or from a near-by woods? Shrubs and trees can be purchased at reasonable prices from nurseries. The members of the class should write for catalogues.

Planting.—In general, you should follow the directions given on page 142 for planting a tree. The plants which are to be transplanted from the home yards should be taken up the same day they are transplanted, and the roots should not be exposed to the sun as they will dry out and fail to grow. If it is necessary to take up the plants before the planting date or if nursery stock is to be used, the plants should be "heeled in" until time for planting. To heel in the plants, dig a trench or a hole in the ground and place the roots in it, covering them with soil which must be kept moist.

You must not attempt to do more than you can do well. Each pupil should be responsible for one kind of shrub or tree. If six lilacs are needed, one or two boys

should be responsible for them and bring them to school and set them in their proper places. If you can enlist the interest and help of your older brothers and your father, ask them to come with you to the school yard on the day set for the planting.

Pruning.—Do not be afraid to prune the shrubs severely, as the root system has been cut down a great deal when the plant was taken from the ground and is not able to supply a large top with the required moisture. Shrubs can usually be cut back to a height of about two feet. Can you explain why plants wilt when they are taken out of the ground?

Watering.—Plenty of water should be used around the roots of the plants when they are set in the ground, but it should not be necessary to water very often after that time. If the ground becomes very dry it should be thoroughly soaked with water as it does the plant little good to sprinkle the ground. Why?

Mulching.—A mulch or covering of leaves, straw, or manure should be placed about the shrubs and trees after the freezing weather sets in. Can you explain why the mulch should be used and why it should be put on after the ground is frozen?

Completing the Map.—The original plan may need revising after the yard is planted. Each shrub and tree should be located on the map and named with its common name. Make a list of all the plants and write a description of each, telling about its habits of growth, kind of flowers, height, time of blossoming, etc.

Facts to be Studied

The Landscape.—Trees and shrubs and flowers should make an appeal to every person. How much more beautiful is the yard that is broken by a maple here, an oak there, and a birch or two, than the bare grounds which glare in the sun's light! We all prefer a walk in the woods to a walk along a dusty, barren road or field; yet most of our school yards are barren and unattractive. If there is any place that should be made inviting it is the school yard where we spend so much of our time while we are children.

Poets have always sung the praises of the trees and flowers. Painters have made these works of nature the models for a large number of their works of art. Why should we not live among the trees and flowers? No greater monument can be erected to a schoolboy's memory than a giant oak or elm which he planted as a boy, or a clump of lilacs giving a portion of their beauty and fragrance to every passer-by.

Arrangement of Plantings.—When one goes into the open fields or woods, he finds winding paths, irregular borders, and trees and shrubs growing in groups or clumps without any definite arrangement other than that made by nature as the seeds were scattered by the wind. Even the streams wind their way among the trees and hills, and no straight line or orderly arrangement is to be found anywhere. When this general style of planting is carried out in our yards it is called

the natural style. It is a mistake to plant trees and shrubs in straight rows like soldiers or sentinels on the school grounds when all around nature has chosen a freer and easier method of grouping the plants. The borders should be planted in curved lines as shown in the illustration and walks should ordinarily be curved to fit into the general scheme of planting although it sometimes happens that it is necessary for convenience to build straight walks in public places. Trees should be placed with regard to their use as shade trees and where their beauty will serve as a background for other plants.

The Open Lawn.—Shrubs should not be planted at random on a lawn, but should be planted about the border so as to form a framework for the yard. The broad open lawn is very desirable especially in school yards where plenty of room is necessary for play. Long unobstructed views are characteristic of the open country and care should be taken not to break the view from inside or outside the yard.

Grouping.—The illustration (Fig. 7) shows the shrubs grouped about the borders in a natural way. It is not enough just to plant a number of shrubs together in one group, but the taller ones should be planted in the rear and the smaller ones arranged in front and planted close enough together to make a solid mass of foliage when the shrubs are mature. A variety of size and color is desirable in all groups. The snowberry shrub has white berries which remain through the winter

while the barberry bears red berries which also remain through the cold weather. If a clump of snowberries is planted near a clump of barberries there will be variety in size and color and yet the whole group will

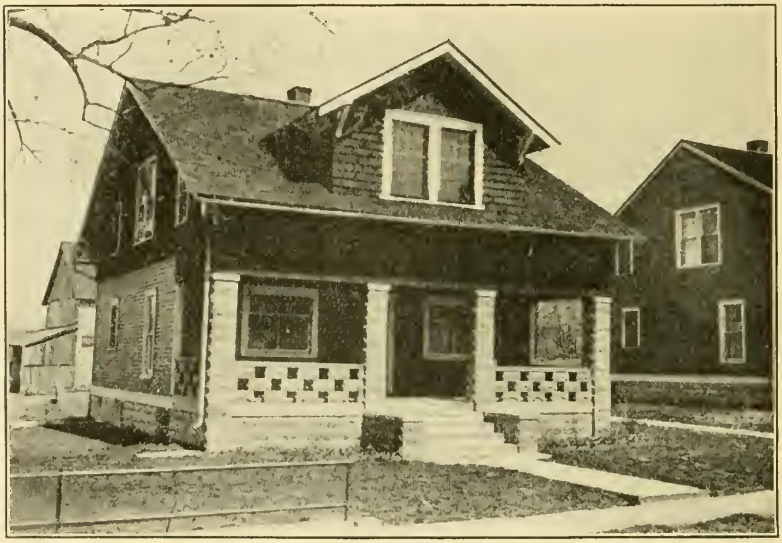


FIG. 8. A BARREN YARD BEFORE PLANTING

not present the "hit-and-miss" appearance that would result if the shrubs were simply scattered about the border.

Vines.—Vines should be used freely in planting the school yard as they make good screens for unsightly places and add a touch of life to surroundings which can not be secured in any other way. The sanitary closets may be covered with vines or screened with a

vine-covered trellis. Clematis and honeysuckle make good screens when used on a trellis.

Suggestion.—The school yard should be partly planted this year. It is very important to outline a

FIG. 9. SAME HOUSE AS FIG. 8. THE CHANGE WAS MADE FOR A COST OF LESS THAN TEN DOLLARS.

plan for this work. Even if all the shrubs cannot be planted in one year, a definite plan should be made and followed. Plant as many as can be obtained this year and place them according to the plan. The expense of purchasing plants may be met through school activities. A part of the income from a basket social, a silver offering taken up at a program

offered by the school, or donations from some of the public-spirited patrons may be used. Sometimes local nurseries or nurseries within the state will be glad

Courtesy Illinois Department Public Instruction.

FIG. 10. A RURAL SCHOOL SHOWING "HOMELIKE" SURROUNDINGS

to donate a few shrubs for school grounds in order to encourage the planting of home grounds. The class should make every effort possible to enlist the interest and support of all the patrons of the school community.

Problems and Review Questions

1. What flowering shrubs can you find growing in the community? List them and give the approximate flowering date of each.

2. Where in the fields and woods have you seen winding paths? Can you tell how they were started?

Fig. 11. Rural school without surroundings shown in Fig. 10

3. What annual flowers are best adapted to your local climate?

4. Draw a plan for a flower bed in your home yard, and name the flowers to be used.

5. Tell how to transplant a young tree.

6. When do farmers set out orchard trees in your community?

7. Collect pictures clipped from nursery catalogues or from farm journals to show the value of planting the home yard.

8. Draw an outline map of your home yard showing the buildings and the trees and shrubs which are already growing. What can you do to improve the planting?

VI

SELECTING SEED CORN

Home Work

Field Work in Seed Selection.—Go into a field of white corn planted near a field of yellow corn. How far must you go before no yellow grains can be found on the white ears? Note the proportion of ears which hang down. How many inches distant from the ground are the lowest ears you can find? How many inches from the ground are the highest ears? Count the number of stalks in one hundred hills of corn. Find the average number per hill. Find the average number of ears on one stalk by counting the number of ears on one hundred stalks. Select enough seed to plant the corn on your farm next year.

The Seed Sack.—Tie the corners of a grain sack so as to make a shoulder strap. Sling the sack from the shoulder, as shown in the illustration on the next page. A hoop placed in the top of the sack makes it more convenient. When the load begins to get heavy, carry it to a wagon or to a central point where it may be picked up later. How many ears can you carry?

The Seed Ear.—Select the corn from a field where the corn has not been crossed with other varieties.

The ear which is chosen for the seed sack is to furnish the seed for almost a thousand stalks of corn next season. This means that a single ear should grow into about twenty bushels of corn. Use great care in making your selection. Choose well-matured, shapely ears of medium size which hang down. The stalk from which the ear is taken should be strong and vigorous. It is best to select from hills where two stalks are growing. Kernels should be deep and broad, not shallow or pointed.

Courtesy Illinois Agricultural Experiment Station.

FIG. 12. THE SEED CORN SACK

Seasoning the Seed.— To season the seed, place the corn which you have selected in a moderately warm room. Hang the ears from supports by placing them in a swing made of twine. Two double cords crossed each time an ear is put in place should be used to bind all the ears together. Be careful to place the corn hanger where the mice cannot reach the corn. If you suspend the hangers by wires the mice will be disappointed.

Note the difference in the time it takes to dry corn in the crib and to dry the seed corn that is hung in a warm room. Weigh ten ears of the corn from week to week until New Year's day to find the loss of moisture. Corn may be stored in wooden racks or in wire racks. The latter may be purchased or made from woven wire. Make suggestions of your own for seed corn racks.

Facts to be Studied

The Ear.—We have already learned that plants grow not to produce food for man, but to produce seed, by means of which the plant reproduces. The ear of corn is the result of a year's growth of the corn plant. All the energies of the plant have been directed toward making this ear of corn. We think of it as valuable because it will furnish food for men and animals. But what is more important, it is the seed for next year's corn crop. It is the fruit of the stalk of corn. When the ear has been completed the plant dies. Most annuals, plants living but one year, die as soon as the fruit or seed is mature. Biennials, plants living two years, usually do not produce seed or fruit the first year.

The Kernel or Seed.—If we examine the kernel of corn, the bean, or any other seed, we find a tiny plant wrapped within the seed. One may think of this tiny plant as being in a basket of food, for the seed is really the food which this tiny plant will use when it begins to grow. In every grain of corn there is a baby corn

plant which will produce a stalk of corn when the grain is planted under good conditions.

It is true that the baby corn plant found in the grain does not look much like the stalk of corn that we see growing in the field. But plant a grain of corn in some moist sand and see how quickly this tiny plant begins to look like a real stalk of corn. The newly hatched chick differs

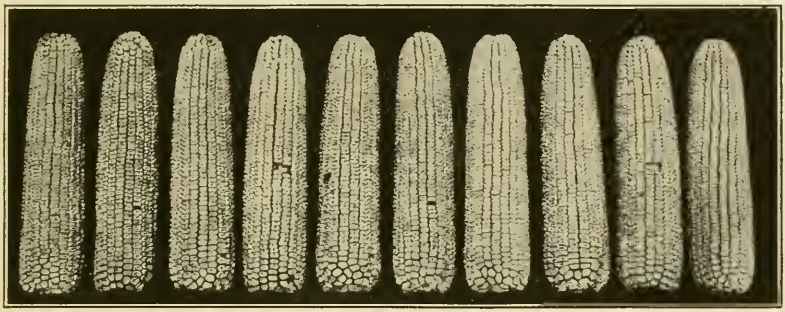


FIG. 13. A SAMPLE OF GOOD SEED CORN

greatly from the mother hen in appearance. Instead of feathers the chick has down, the comb is undeveloped, and the color is not the same as that of the mother hen. So it is with the baby corn plant which we find in the kernel of corn; it has not yet developed the earmarks of the mature stalk of corn. The baby corn plant needs protection from the weather as much as the baby chick needs protection. Cold, wet weather will injure either.

Careful Selection Necessary.—At the University of Illinois two plots of corn were planted to show whether the earmarks of corn could be changed by selection of

seed. One plot was planted with kernels from an ear of corn which had grown low on the stalk. The other was planted with kernels from an ear which had grown high on the stalk. The next year the first plot had many low ears and the second had many high ears. The lowest ears from the first plot were selected for seed for this plot the next year. The second plot was planted with seed from the highest ears found in the plot. This process was repeated for six years. At the end of this time, the average height of the ears in the first plot was less than two feet. The ears in the other plot averaged almost five feet from the ground.

This experiment proves to us that the kernel of corn will produce corn much like the mother plant. The corn will have the same color as the seed. The new stalk will be like the stalk from which the seed is taken. If the seed ear grew five feet from the ground, a large proportion of the ears in the next crop will grow about five feet from the ground.

If the farmer wishes to have his corn hang down for husking, he should select seed ears that hang down. Ears that hang down shed water and are not injured by rain and snow as upright ears are.

Place to Select Seed.—There is but one place to select seed corn; that is, in the field where it grows. When you pick the seed ears from the corn in the crib you cannot tell whether the ear you select hung down or grew upright on the stalk. You cannot tell whether the ear grew five feet or two feet from the ground.

Time to Select.—Seed corn should be selected before the freezing weather sets in. However, the corn should be mature. The time of selecting will be before the regular husking time in most places. At this time you have the whole field to select from. If corn is allowed to remain in the field through the wet freezing weather, the baby corn plant or embryo in the seed is liable to be injured.

Storage of Seed.—After the corn is picked it should be seasoned thoroughly in a moderately warm room. The air in the room should circulate freely in order to carry away the moisture. Good storage houses for seed corn are usually provided with furnace heat and with fans which force the air through the racks of corn. The author examined such a storage room filled with corn and found the corn in excellent condition in the month of January. In the same town was a storage room without heat and without ventilation; in fact, it was an old grocery store. The shelves had been filled with corn in the fall; the doors and windows had been kept closed. So much moisture had collected in this room that the doors of the building were warped. The corn on many of the shelves was covered with mold. Corn kept under such conditions will not grow into strong stalks when planted.

Problems and Review Exercises

1. On the map of the neighborhood which has been outlined, shade the portions which were planted with corn last year.

2. The class should arrange an exhibit of seed corn. Each member of the class may bring a ten-ear sample of the best corn he

can find. Ask one of the corn growers of the community to come in and judge the samples. How many shapes of kernels can you find in a dozen ears? How many rows on each of ten ears?

3. Make up an exhibit of varieties of corn grown in the neighborhood by using one ear of each variety. These ears may be fastened to a smooth board and made to look very attractive. Note the differences in the varieties.

4. Estimate the number of ears required to plant one acre. Is corn drilled or checked in your locality? What is the advantage of each method of planting?

5. What are some earmarks or qualities of corn which you think should be changed by selecting seed in the field?

6. What can you do in order to change these qualities in your own field?

VII

THE WHEAT CROP

Home Work

Survey.—Make a survey of your community to learn the acreage of wheat grown and after the data has been collected from the farms, shade the areas on your outline maps which are to be planted in wheat this year. What varieties of wheat are grown? Is the wheat hard or soft? Is most of wheat bearded or beardless? Ask the farmers about the bearded and beardless wheat. What advantages are claimed for each kind? What is the usual planting date in your community? How much is sowed per acre? What crop is usually followed by wheat?

The Hessian Fly.—Go into a wheat field and examine a number of stalks for the Hessian fly. The fly may be found in the stalk of the wheat as a small white worm called the *larva*. It may be in a tiny brown case which looks like a flaxseed. We call this the *pupa*. You may have to hunt for some time and to examine many stalks in order to find the Hessian fly. If the wheat has been planted very late perhaps there will be no flies. Bring specimens of the larva or of the brown pupa to school for class study. How does the fly affect

FIG. 14. DIAGRAM SHOWING THE DEVELOPMENT OF THE HESSIAN FLY (AFTER WALTON, UNITED STATES BUREAU OF ENTOMOLOGY)

the stalk? What is likely to happen to the stalk the next spring? (See page 49 for the life of the Hessian fly.)

Study of Flour.—Compare wheat bread made from high-grade flour with other breads, such as cornbread, whole-wheat bread, and rye bread. What differences in color, taste, texture, and quality do you find? If a flour mill is available in a near-by town, the members of the class should visit the mill and study the different processes in flour making. Secure samples of all the products made from wheat which are used on your farm. Name other products which you have read about.

Facts to be Studied

Importance.—As a food crop, wheat is one of the most important grain crops of the world. The United States produces more wheat than any other country, producing more than a billion bushels in 1915. Usually the wheat crop is less than that amount. Wheat bread is so common in this country that we are likely to consider it the common diet of all the people of the world. However, there are many people who have never tasted white-flour bread. Perhaps one half of the population of the world use other kinds of cereals as the main part of their daily ration, rice being the main food cereal in Oriental countries. The importance of wheat as a food was evident during the World War, when the movement of great armies in Europe was often limited by the wheat supply. It is said that at one time during the

war there was only enough wheat in France to supply the people for three days, but more was coming into the country from the United States every day.

Wheat Areas and Yield in the United States.—The great wheat areas in the United States are in the North and West, Minnesota and Kansas being among the greatest wheat-producing states. The North Central States and the Dakotas also produce much wheat. The yield of the ten states having the highest yields in 1918, according to the United States Year Book, was as follows:

1.	Kansas	137,056,000 bushels
2.	North Dakota	68,400,000 bushels
3.	Nebraska	60,480,000 bushels
4.	Oklahoma	46,240,000 bushels
5.	Illinois	40,670,000 bushels
6.	Washington	37,982,000 bushels
7.	Missouri	32,721,000 bushels
8.	Minnesota	29,116,000 bushels
9.	Ohio	28,698,000 bushels
10.	South Dakota	26,282,000 bushels

Types of Wheat.—There are three types of wheat: the hard, the semi-hard, and the soft. The harder wheat is grown in the North and West, where the climate is dry, while the soft wheat is grown in the more humid climates. Wheat is also classified as spring wheat and winter wheat. Spring wheat is grown where the winters are too severe for winter wheat, while in warm sections, winter wheat is grown. Spring wheat

is also grown to some extent as far south as St. Louis, Missouri. Winter wheat is planted in the fall and is ready for harvest from seven to eight months later. Most of the wheat grown in the United States is of this type. The hard wheats make a higher grade of flour for bread than soft wheats, but the flour made from the latter is better for pastries than the hard wheat flour.

Planting.—Wheat requires a good seed bed, well pulverized, and made firm by much working and rolling, experiments having proved that early plowed ground gives the best results. If winter wheat is to be planted in October, the ground should be plowed in August or the early part of September, thus saving moisture and insuring a firm seed bed. Plowing at this time also kills many weeds which would otherwise shed their seeds in the soil. Winter wheat should be planted as late as possible to escape the damage done by the Hessian fly, which lays its eggs each year at about the same time in the fall. If the wheat is planted late, the flies lay their eggs before the wheat comes up, and do not damage the wheat. The seed should be well cleaned and fanned to rid it of light grains and weed seed.

Cheat in Wheat.—Many farmers believe that wheat turns to cheat after a few years if the seed is not renewed, but this is not true, as the cheat is a plant very different from the wheat plant. Cheat seed looks like wheat, except that it is smaller, and may be in the wheat seed when it is sown without being noticed by the farmer. It spreads very rapidly, a few grains in the

seed wheat producing large quantities the next year. Care should be exercised to have the seed wheat free from cheat.

Care of the Wheat Field in Winter.—The wheat must live through the winter, and frequently it is injured by weather conditions. A long dry fall with a cold dry winter injures wheat because the plants do not get the proper start after planting. Heavy snows during the winter are considered very beneficial to wheat. Freezing and thawing of the ground injures wheat by "pulling" it from the soil. Damage of this sort can be avoided by covering the ground with a thin layer of straw after the wheat comes up. Every boy knows that the ground in winter will remain frozen under boards even when the surface is thawing each day and freezing at night. The straw has the same effect as the boards, the ground remaining frozen during the day, thus preventing the "pulling" which otherwise would occur. There are straw spreaders on the market, which spread the straw in thin layers. The straw should be put on late in the fall, after the ground is frozen.

Diseases.—There are a few diseases that are responsible for great losses in the wheat crop. *Smut* is a disease which attacks the grains of wheat, destroying them, or making them so light that the grain is worthless for feeding, the two main smuts being *stinking smut* and *loose smut*. The former can be eliminated to a very great extent by treating the seed with formaldehyde, as suggested for oats smut. The loose smut is

killed by treating the seed with hot water, from 128° to 132° Fahrenheit, for five minutes. The smuts spread by tiny spores or "seeds" which are blown by the wind, and which remain on the seed wheat. *Rust* is a disease which attacks the leaves of wheat, and affects it by checking growth. If you were to walk through a wheat field which was affected with rust, your shoes and clothing would be covered with a fine red substance like iron rust. There is no remedy known for the disease. *Scab* is another disease which affects the head of wheat, injuring the covering of the grains.

Insects in Wheat.—There are two insects which are very injurious to wheat. The most widely distributed is the Hessian fly which lays its eggs in the young wheat soon after it comes up in the fall. A little white worm which hatches from the eggs eats its way into the stalk and remains there all winter. In the stalk it changes to a brown pupa or "flaxseed," so called from its resemblance to a flaxseed; and in the spring the adult fly comes out of the stalk, leaving a hole where it rested during the winter. This is very injurious to the wheat, having the same effect upon the wheat plant as girdling or barking has upon a tree. Wheat stalks affected by a number of Hessian flies are liable to fall or break when they begin to grow up in the spring, because the tiny holes left by the flies when they come out in the spring weaken the stalk to such an extent that it cannot withstand the wind. The flies which come from the wheat stalks in the spring lay eggs and produce another

crop of worms, but the wheat is so far along at this time that little damage is done by the spring brood.

Late planting in the fall is the best preventive, because if the wheat comes up after the fly has laid its eggs, it will not be damaged by the little worms, for they remain where they hatch out,—probably in grass stalks if no wheat is present.

The Chinch Bug.—The chinch bug has proved to be a very dangerous enemy to the wheat in certain sections of the United States. Perhaps the area most seriously affected is the wheat section within a radius of one hundred miles of St. Louis, Missouri, where this insect has done millions of dollars worth of damage.

Fig. 15.
Adult chinch bug
(greatly enlarged)

The chinch bug is a small bug which lays its eggs in the wheat or oats early in the spring, just as the plants are beginning their growth. The insect does not have a "worm stage," but hatches into a tiny light-colored wingless bug resembling the adult bug in shape. These young insects feed on the growing plants near the crown of the roots. As the insect grows it changes in color to a red and then to grey. The wings develop gradually. It is full grown about the time the wheat is ready to harvest, but it does not fly until some time later. Instead, the bugs crawl from the wheat fields to the surrounding fields. At this time they do great damage to

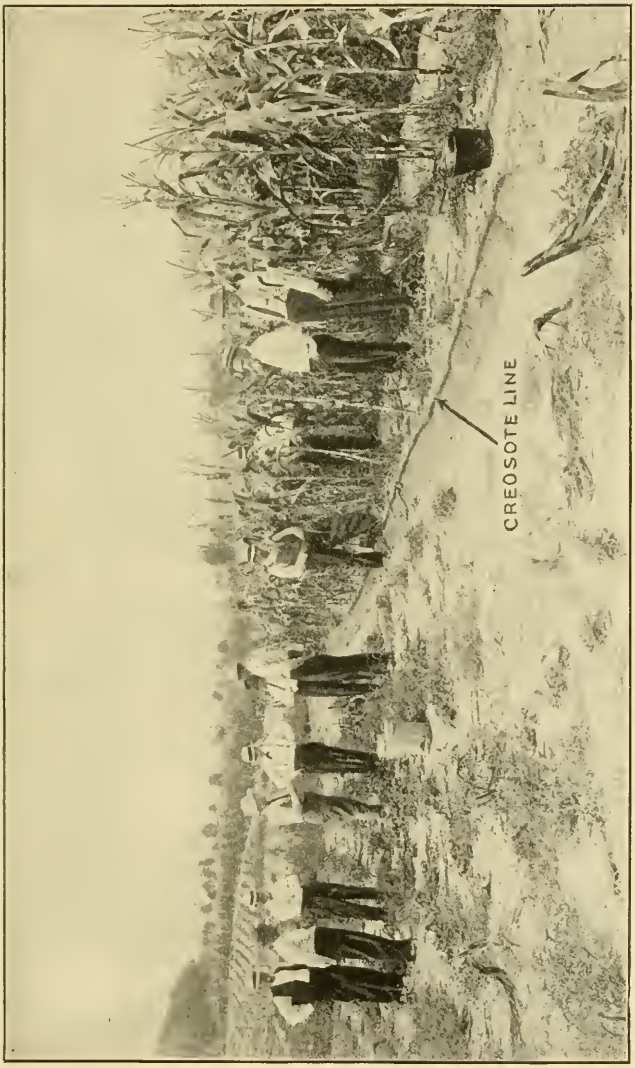


FIG. 16. SAVING CORN FROM CHINCH BUGS. THE CORN WAS AS GOOD ON THE LEFT AS ON THE RIGHT UNTIL THE CHINCH BUGS CAME. THE CREOSOTE LINE STOPPED THEM AND SAVED THE CORN ON THE RIGHT.

corn. The writer has seen corn fields destroyed by the chinch bug within a short time after wheat harvest. The best check is a tar line spread around the fields. The bugs will not cross this line and if holes are dug at intervals along the tar line, the bugs fall into them as they crawl up and down the line trying to find a place to cross. The holes will often be found full of chinch bugs within a short time. In a county where chinch bugs were very widely distributed in the year 1914, the author saw one field of corn almost completely destroyed by these bugs because it was unprotected, while another field of corn, saved from the attack by a tar line, produced forty bushels of corn per acre. Chinch bugs live during the winter in rubbish, dead weeds, fences, and other shelters.

Problems and Review Exercises

1. On an outline map of the United States, shade the principal wheat-growing areas.

2. Each pupil should bring a sample of the wheat grown at home to school for an exhibit. Compare the different varieties.

3. Clip articles from farm journals about the insects and diseases which affect wheat. Bring the articles to school for discussion.

4. Write a composition on one of the following subjects:—"Making Bread," "Threshing Wheat," "Planting Wheat."

5. Describe the damage done by different insects and diseases. Discuss in class the remedies used by the farmers in your community to destroy the insects and to prevent diseases. Which remedies give the best results?

6. What is considered a good yield of wheat per acre in your locality? Is there a large variation in the yield per acre on different farms? Can you give reasons for this variation in yield?

7. Considering the cost of machinery and other expense connected with raising the wheat crops on your farm, how many bushels of wheat at current prices will your crop have to yield per acre to pay the cost of producing the crop?

8. What fertilizers have been used in the community on wheat ground? What results have been obtained?

9. The members of the class should bring to school stalks of wheat showing rust and smut. Also collect stalks that have been injured by the Hessian fly.

10. Prepare a table giving the different wheat diseases, their effects and remedies. Do the same for injurious insects.

VIII

WEEDS

Home Work

The purpose of our observation of weeds as they grow in the field is to learn something definite about the most common weeds in the locality and to try to discover a way of preventing the further growth and spreading of these weeds.

On the way to school, count the number of different kinds of weeds found. It will be interesting to learn which member of your class can find most kinds of weeds. Collect weeds and bring them to school where they may be studied. The teacher will aid in pressing these specimens to make up a school exhibit of the common weeds. Notice the tails of horses or the wool of sheep to find seeds of injurious weeds. Collect the seed of cockleburr, tumbleweed, milkweed, plantain, quackgrass, and sticktight and try to find out how they might be distributed from field to field. Will they float on water? Do they stick to clothing or animals? Does the wind carry them? Are the seeds likely to be found in seeds of the economic crops such as clover? Collect such weeds as you can find which have beautiful flowers. Cut off some of the common weeds and watch them to learn whether

they come up again from the roots. Sprinkle salt or brine about the roots of weeds and note the results. Count the number of weeds in a square rod in the corn field, or in any other field where a cultivated crop is growing.

Do horses and cattle eat any weeds found growing on your farm? What weeds bear seeds most abundantly? Estimate the number of seeds on a smartweed. Where have you seen wild lettuce growing abundantly?

Facts to be Studied

Weeds and the Damage They Do.—Weeds are undesirable plants—they are "spongers," robbers, parasites, tramps. The weed has been defined as a plant out of place, which suggests that any plant may be classed as a weed if it is so out of place as to become a nuisance or an annoyance to the farmer. Professor L. H. Bailey says: "A weed is a plant not wanted. There are, therefore, no species of weeds, for a plant that is a weed in one place may not be a weed in another."

Weeds do much damage to crops. Sometimes they ruin whole fields of economic plants such as corn, oats, and wheat. The author has seen wild lettuce growing so thick and high in an oats field that no oats could be seen growing. Morning glories sometimes ruin the corn crop. Such weeds as ragweed, smartweed, and quackgrass are likely to be found in the garden.

Some weeds, such as smartweed and the horse nettle, live from year to year, and are called perennials.

Others live but one year, coming up the next year from the seed that was allowed to ripen the year before. An example of this class is the morning glory. Such plants are classified as annuals. Others such as the wild carrot, sometimes called bird's nest, are called biennials because they live two years.

Kinds of Damage Done.—Weeds should not be allowed to grow for the following reasons:

1. They rob the plant of sunlight by growing up and shading the plants.

2. They rob the other plants of food and water. Crops like corn are cultivated mainly to keep down the growth of weeds. The weeds require so much water that the corn plant soon suffers if the weeds are allowed to grow.

3. Weeds make a farm look untidy. They show shiftlessness on the part of the farmer.

4. Weeds in a crop make the harvesting processes much more difficult. Any one who has shocked wheat or oats where nettles or thistles were growing knows what trouble these weeds cause the farmer.

5. Some weeds injure the live stock. Burrs injure the wool of sheep. Ragweed and wild onion cause the cow's milk to have a bitter taste.

6. Grains are made less marketable. Clover seed containing weed seed is worth less than clean seed. Wheat containing cheat is less valuable. The cheat grains impair the quality of the flour made from wheat. Much grain is lowered in value because of the presence of weed seed.

7. It is because of the presence of weeds in our crops that so much labor is required in preparation of the soil and in further cultivation. Labor in raising crops can be greatly reduced if the weeds can be held in check or prevented from growing.

Weeds Spread Rapidly and Grow Abundantly.—Weeds are more hardy than the cultivated plants. They spread more rapidly because they have so many seeds. Single large plants may have as many as half a million seeds, which gives them a marked advantage over the ordinary plants that are cultivated. The seeds are usually easily distributed as you will have learned by your observation of the weeds mentioned in the questions. Some of the weed seeds, mustard for example, live for many years so that weeds may come up one year from seeds which were distributed many years before.

Control of Weeds.—There are many things which a farmer can do to prevent or to check the growth of weeds. He should be sure that the seed which he plants is free from weed seed. The author knows of an instance which illustrates the danger from sowing unclean seed. A man bought a load of clover seed screenings which he supposed would contain enough clover seed to make it profitable for him to sow it on his field. Within a year or two there were so many weeds on this field that it was almost impossible to harvest the crop. It would have paid him better to have bought a single peck of clean clover seed instead of the load of screenings.

Destroying Weeds.—The crops should be rotated from year to year. Weeds that grow in the clover crop may be destroyed the year following by cultivation if corn is planted in the field. Weeds should be kept cut to the ground in fence corners, barn yards, and other uncultivated areas. Crops which need care should

be cultivated often enough to keep the weeds from getting a start. Weeds come up quickly after a rain, hence this is the best time to kill them. Sometimes weeds may be destroyed by sheep. If the corn field is weedy, sheep may be run in the field while the weeds are yet green in the fall. They will clean up the field without damaging the corn to any great extent. Boys should try to develop a hostile attitude toward weeds. Do not neglect to pull up a cockleburr that escapes the cultivator; it takes a little more time, but will save labor and waste in the end. The community should declare war on weeds. If one man allows weeds to grow unchecked on his farm, all his neighbors will suffer loss of crops due to his negligence, because seeds are so easily distributed. Remember that millions of dollars may be saved to the country if the growth of weeds can be checked.

Problems and Review Exercises

1. What is a weed?
2. What are the three classes of weeds?
3. Give the common ways by which weed seeds are distributed.
4. What weeds cause milk to be bitter?
5. What is the most troublesome weed to be found on your farm?
6. In what ways do weeds damage the farm crops?
7. What weeds are said to be poisonous?
8. Why do weeds have a better chance to grow than cultivated crops?
9. Give different methods employed in controlling the growth of weeds on your farm.

IX

CROP ROTATION

Home Work

Rotations in the Community.—A survey of the community should be made to determine the kinds of crops which the farmers grow and the order in which they are planted in one field. How many different rotations are found? What grasses and clovers seem to be grown most widely in the community? Find the total area which was planted in clover this year. Each pupil should report on a particular part of the school community. What is the total area of land represented? What per cent of this area was in clover during the season? What crop is usually planted after clover? What crop precedes it on your farm? Do farmers plow the clover crop under? The survey should show not only the area given to clover, but to other crops as well. Tabulate as follows:

Farm	Total Acreage	Acres of Clover	Acres of Alfalfa	Acres of Other Crops Grown

Pasture Land.—How many acres of permanent pasture land are there on your farm? What grasses are

used mostly for pasture in the community? Make a study of the pasture land and its use on your farm. Could more money be made by using the soil for a cultivated crop such as corn or wheat? Would it be possible to supply silage or other green crops to live stock during the months when they are usually on pasture? Discuss the advantages and disadvantages of such a plan.

Forage for Live Stock.—Make a list of all roughage or forage crops used for feed on your farm. Does the farm produce all the hay needed for the live stock? What forage crops or hays are fed for milk production? What forage crops are fed to horses? Estimate the number of tons of hay fed in one year on your farm.

Facts to be Studied

What Is Rotation?—Rotation of crops is the changing of the crops on the various fields of the farm from year to year so that there will not be a continuous growth of one crop on any part of the farm. On some grain farms a rotation of corn, oats, and clover is practiced; that is, corn is grown in a field one year, oats is grown in that field the next year, and clover is grown in the field the following year. By dividing the farm into fields it is possible to have a rotation on the different fields and to have all the crops growing each year. There are many advantages of crop rotation which deserve mention in this discussion.

Advantages.—Not only is crop rotation on a given field desirable but more than one crop should be grown at the same time. If but one crop is grown on the farm, much labor is required at the time when the planting and the harvesting are done, while at other times comparatively little labor is required. There cannot be permanent employment for labor unless crops are grown which mature at different times. Another advantage of crop rotation is that weeds are killed by cultivation. If the whole farm is planted with a crop such as timothy, which does not require cultivation, and no cultivated crop is planted for several years, the weeds will gain a foothold and probably crowd out the crop. When wild lettuce once gets a foothold in the oats field, it spreads rapidly and unless a cultivated crop is planted the next year, the lettuce will take the crop. (We shall learn something about the clovers in Chapter XXI and will find how valuable they are for feeding animals and for adding fertility to the soil.) By rotating the crops, the advantages of clovers may be secured and the fertility added by legumes will thus be distributed over the farms.

Live Stock and Rotation.—Crop rotation is good practice for the live stock farmer, because if but one crop is grown on the farm, live stock cannot be fed unless much feed is purchased; thus, by growing a variety of crops, more economy in feeding will be realized.

Increased Yields.—Corn yields better when rotated with other crops. The claim is made that some crops

if grown too long on the same field poison the soil and prevent the growth of that crop. Whether there is much danger of soil poisoning or not, we know that crops yield better when they are not grown continuously on the same field. Corn yields much better when rotated with oats than when grown continuously. This fact has led some farmers to believe that corn and oats do not require the same kind of plant food, which is a mistaken idea. Both crops take the same food elements from the soil but they take the elements in different proportions.

An experiment has been conducted by the Illinois Experiment Station since 1888 to test the value of crop rotation. In this experiment three plots of good brown silt loam soil have been used. On one plot, corn has been grown continuously, on another corn and oats are rotated, and on the third corn, oats, and clover are rotated. The average yields of corn during ten years of cropping (1908–1917) are as follows:*

Plot No. 1	Plot No. 2	Plot No. 3
Corn continuously 10 years; 28.3 bu. Corn per acre; average 10 crops 1908–1917.	Corn and oats rotated 10 years; 37.6 bu. Corn per acre; average 5 crops 1908–1917.	Corn, oats, and clover 10 years; 40.7 bu. Corn per acre; average 3 crops 1908–1917.

The soil used in this experiment was not treated in any way with commercial fertilizer, the difference in yield being due to rotation in crops. These plots are still being kept up and are giving even more conclusive

* Bul. No. 219, Agr. Exp. Sta. U. of Ill.

evidence each year. Experiments have been conducted in many other places proving the value of rotation. No farmer can afford to grow any crop continuously. Cotton grown continuously will destroy the fertility of the soil just as continuous corn crops do.

Problems and Review Exercises

1. Discuss the advantages and disadvantages of the rotation used on your farm. What principles of rotation are involved?

2. Give the essential points of crop rotation mentioned in the University of Illinois Experiment.

3. At current prices of corn, what was the value per acre of the ten crops of corn produced on Plot No. 1 from 1908–1917? What was the average value per acre per year? Compare these values with the values of the corn crops on each of the other plots during this time.

4. The five crops of oats grown on Plot No. 2 during the ten-year period, 1908–1917, averaged 38.6 bushels. What was the total value per acre of the corn crop and oats crop on this plot during the ten-year period? Use current prices.

5. Would the grain farmer who raised no live stock to sell, be likely to grow the same crops in a rotation as a live stock farmer?

6. On a map of your home farm indicate the crops grown this year. What crops will be grown next year on the various fields?

7. Propose a three-year rotation of crops adapted to the conditions in your community. Talk this over with your father.

X

SOIL FERTILITY

Home Work

Yields.—Study the production of food in your community, and collect all the information you can get concerning the yields of all crops grown in the community, tabulating each crop separately. Use the following form for tabulation:

Crop: *Corn*

Farm	Number of Acres	Average Yield	Total Yield	Value
Mr. A.	40	40	1600	$1200
Totals				

Causes of Variation in Yield.—What factors can you observe which seem to cause the differences in yields? Learn all you can about the soil which yielded the largest crop. How does it differ from the soil which yielded the smallest crop? On which fields was manure applied? What differences can you see in the growing crop where manure has been applied and where nothing has been applied? Do those farms which produced the largest yield grow most live stock? What differences in color do you find among the soils? What kinds of fertilizers are used on the soil? Has the yield of the

crops on your home farm decreased or increased during the last ten-year period? To what is the decrease or increase due? Will the value of the product grown on an acre of ground on your home farm purchase as much clothing for the family as the value produced by the same acre ten years ago would have purchased at that time?

Facts to be Studied

Importance of Increasing Crop Yields.—The population of the United States is increasing more rapidly than the production of food products is increasing, which is one cause of the present high cost of living. The demand is rapidly becoming greater than the supply, and as there is comparatively little untilled land at present, our hope for the future lies in increased yields. Experiments have proved that yields can be increased greatly by proper attention to the soil. The farmer of the next generation cannot farm as his father and grandfather farmed, or the world will suffer from the lack of sufficient food.

What Is Soil Fertility?—We have learned in another chapter that all plants require food just as animals require food to keep them alive and to make them grow. If animals are shut in a barn yard and food is kept away from them, they will soon die. Plants will not live unless they are furnished with plenty of food and water. Some of the plant's nourishment comes from the air and if the plant were able to live entirely from the food

it obtains from the air, the soil would not be an important factor in crop production. The plant cannot live on this food alone, although about ninety-eight per cent of its weight is made up of the carbon which is

Courtesy Illinois Agricultural Experiment Station.

FIG. 17. SHOWING THE NECESSITY OF BUILDING UP POOR LAND BY THE USE OF PLANT FOODS, IF FARMING IS TO BE PROFITABLE

taken from the air by the leaves of the plant. There are some elements of plant food, mostly mineral elements, contained in the soil which are necessary to plant growth. The plant, as we have said, requires ten different food elements or substances for growth. They are:

(a) Carbon, hydrogen, and oxygen, obtained from the air and water.

(b) Calcium, magnesium, iron, sulphur, phosphorus, potassium, and nitrogen, obtained from the soil.

If an abundance of all the elements named in group (b) is contained in the soil, the soil is said to be fertile. If the soil lacks one or more of the elements named, it is said to be unfertile or low in fertility. Fertile soil is called "rich" soil, and unfertile soil is generally known as "poor" soil.

How Rich Soil Becomes Poor.—Plants live on the food from the soil in much the same way that horses live on the grass of the pasture. The horses will thrive as long as plenty of grass remains in the pasture, but when the pasture gets "low," the horses begin to lose flesh. Horses that are allowed to remain on the pasture lands of the north and west after the grass is gone, sometimes die of starvation. Plants thrive as long as there is plenty of food in the soil but after a few years of continuous cropping, the plants do not thrive so well and will finally cease to grow unless more food is applied to the soils.

Soils may become unfertile through a loss of plant food due to the washing and leaching of rains, and if soils are allowed to remain without care, they are likely to lose much food in this way. Hillsides become poor very rapidly due to the rains which wash the plant food down into the valleys, where it remains to make the bottom lands richer than before.

Earmarks of Poor Soil.—One can tell much about the fertility of the soil by observing the crops that grow on it. Plants that grow on a poor soil are usually smaller and have less foliage than those growing on a rich soil, and the color is not so dark and green as it should be. Corn which grows on a poor soil usually has a yellow color rather than the deep green color which it should have. Such plants as red sorrel and white top are likely to be found growing on sour unfertile soils. Drought affects crops growing on poor soils much more than on rich soils. Plants that have plenty of food are stronger and are better able to withstand the effects of dry weather because they have made a better growth. Rich soils cause plants to grow more rapidly and thus reach maturity earlier, although plants growing on poor soil sometimes become dry and stop growth, thus apparently reaching maturity at an early date. Real maturity has not as a rule been reached in such instances.

Food Elements Most Needed.—As stated before, food is obtained from the air by the leaves of the plant, while the remainder must be obtained from the soil. There is an abundant supply of iron in the soil to supply the crops. The required substances are found in most soils with the exception of nitrogen, phosphorus, and potassium. We shall learn that nitrogen may be secured by growing such crops as clover, alfalfa, and soybeans, but phosphorus and potassium must be applied to the soil in the form of fertilizer of some kind.

Barnyard manure contains all three elements and will increase the yields of crops. Farmers are likely to underestimate the value of the manure produced on the farm. If the manure is piled out of doors and exposed to rain and snow for several months, from one half to two thirds of its value as a fertilizer will be lost. This loss is due to "*heating,*" and to *washing* from rains. Manure should be kept in concrete pits, preferably under cover, or hauled to the fields and spread frequently. Progressive farmers rotate the crops and "plow under" some green crop, usually clover, once every three or four years. This improves the condition of the soil and makes it richer.

Value of Fertilizers.—While it is true that yields can be increased by applying large quantities of manure to the soil and by plowing clover under, it is also true that there are some substances which cannot be supplied in large enough quantities by this method. Farmers use large quantities of ground rock phosphate which is a rock containing the phosphorus needed by plants. This rock is taken from the quarries in Idaho, Tennessee, and some other states where it is found in large quantities, then ground or crushed until it is very fine, and put on the soil. About a half ton per acre is considered a fair amount to use. Bone meal, a finely pulverized substance made by grinding the bones of animals, is also used extensively and is an excellent fertilizer for increasing crop yields quickly. Other forms of mineral fertilizers are used by

farmers in order to increase crop yields. Fertilizer companies sell many brands of fertilizers called "complete fertilizers" because they contain all the mineral substances usually lacking in soils, but most of these fertilizers are expensive and are not so profitable to the farmer as the ground rock phosphate, limestone, and manure.

The important point to be remembered in connection with soil fertility is that farmers should grow clover and turn under some green crops of it in order to make the soil more fertile. Farmers should consult the agricultural agent in the county or write to the state experiment station to find out what kinds of fertilizer are best for the soils in the community.

Review Exercises

1. The largest wheat crop produced in the United States was 1,000,000,000 bushels. If five bushels of wheat make one barrel of flour, from which 240 loaves of bread, each weighing one pound, may be made, how many loaves of bread per person could have been made in 1915, when this crop was produced? The population of the United States at that time was approximately 100,000,000 persons. Assume that all the wheat remained in this country and was made into flour.

2. How many loaves of bread could have been made from the wheat produced on your farm this year?

3. What per cent of the crops produced on your farm this year was sold from the farm?

4. Give suggestions for improving the crop yields on your farm.

5. What is meant by the term "plant food"?

6. Give examples of the use of fertilizer in your community.

7. Make a study of one or two fields on your farm to find out what fertilizer should be used this year.

8. If crops look yellow, it is likely that the soil does not contain enough nitrogen. Observe the crops in your community to determine whether nitrogen is needed in the soil.

XI

THE USE OF LIMESTONE ON SOILS

Home Work

The exercises to be worked out at home in connection with the use of lime will consist of a few simple experiments which every boy and girl can easily perform. The purpose of these experiments is to show the effect of lime upon soils.

1. Add a half teaspoonful of baking soda to a little vinegar in a glass and note the result. Taste this foaming liquid as soon as the soda is stirred into the vinegar, then taste the liquid that remains after the foam has disappeared. What difference do you notice? The soda corresponds to the limestone and the vinegar to the acid in the soil. The action of the soda and vinegar is similar to that of limestone and acid in the soil.

2. Place a lump of quicklime in a box and add water slowly. What happens? Compare the quicklime with lime which has been airslaked by remaining exposed to the air for a long time. If limestone is available, compare it with other forms of lime. Common marble is limestone. Add some vinegar to a piece of marble or limestone and note what happens after a few days' time.

3. Obtain prices on limestone in carload lots delivered to your town.

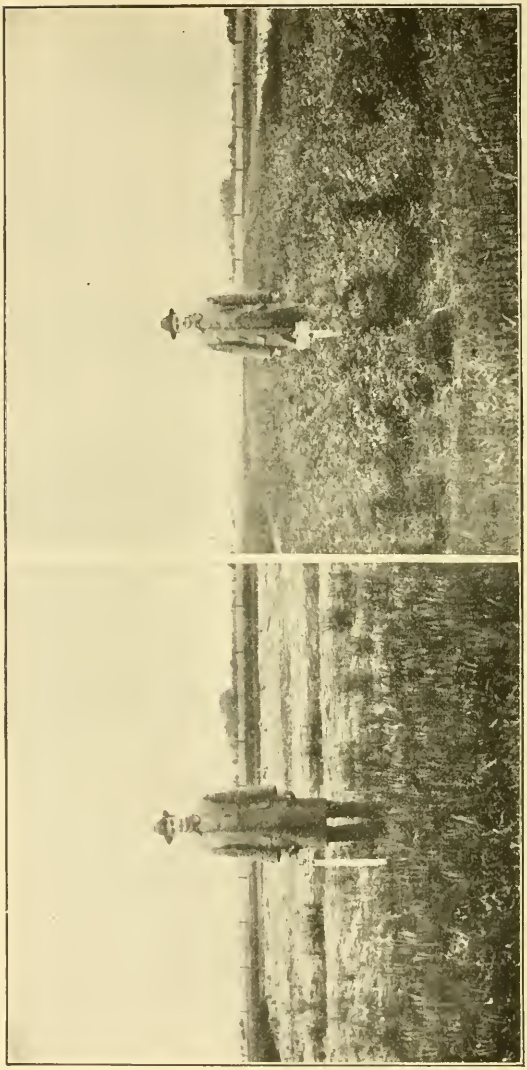
4. Is limestone used in your community? Ask some of the farmers to tell you why they purchase limestone. How much is put on an acre of soil?

Facts to be Studied

Sour Soils.—Many soils become sour after they have been cropped for long periods of time. A sour soil is one which contains some acid. Such soils do not contain enough acid to make them like vinegar to the taste, but do contain enough to show acid when tested and to have a bad effect upon crops.

Test for Acid.—The methods of testing for acid in soil are simple, the simplest test being the litmus paper test. Litmus paper is paper which is saturated with litmus, a kind of blue dye, which turns red when it comes in contact with acid. When the red litmus is then placed in contact with an alkali, such as common ash lye or washing lye, the blue color is restored. When blue litmus paper is placed in contact with wet soils containing acid, it turns pink or red because of the effect of the acid on the litmus. If no acid is present in the soil, the paper does not change color. The paper should be allowed to remain on the wet soil for ten minutes. Litmus paper costs very little, and may be purchased at any drug store.

Effect of Acid in Soils.—Legumes such as clover, alfalfa, and soy-beans do not thrive in sour soils. Soil may become so sour that clover will not grow at all. Acid in the soil checks the growth of most other crops. A few crops such as redtop seem to thrive in sour soils, red sorrel growing abundantly in sour soils. Many other weeds will be found growing on sour soils where



Courtesy Illinois Agricultural Experiment Station.

FIG. 18. THE PLOT TO THE LEFT HAD NO LIMESTONE, WHILE THE PLOT TO THE RIGHT WAS TREATED WITH LIMESTONE. A GOOD ILLUSTRATION OF THE NECESSITY OF USING LIMESTONE ON SOUR SOILS

clover will not grow. If red sorrel is found in a field, it is a clear indication that the soil is sour and needs lime.

Improving Sour Soils.—The first step in improving sour soils is the addition of something which will destroy the acid. You have found by adding soda to vinegar and allowing it to stand a few minutes that the sourness has been taken from the vinegar. Soda would have the same effect upon the acid in the soil, but of course no farmer could afford to buy such an expensive substance to put on his soil. Lime will act in the same way, destroying the acid present; and as it is comparatively inexpensive, it is being used very widely to destroy the sourness in soils. Quicklime is usually thought to be too caustic; that is, it will burn the roots, leaves, and other organic matter in soils and should not be used. Slaked lime may be applied, but it is more expensive than limestone. The best form to use is the limestone which comes directly from the quarry. This stone is crushed and applied to the soils as a finely pulverized rock. Quicklime is obtained from limestone by partially burning the limestone or lime rock in kilns.

How to Apply.—The simplest way to apply limestone is to spread it with shovels from the wagon bed as the load is hauled over the ground, but many farmers consider that this method requires too much hard work and use a limestone spreader. The spreader looks much like a grain drill and spreads the lime as a drill

drops the grain. When this method is followed, the lime is usually hauled to the field and piled in convenient places where the spreader may be filled. One method is to attach the spreader to the rear end of a wagon which is loaded with limestone. One man drives the team while another keeps the spreader filled with limestone, but of course this makes a very heavy load for the horses or tractor to draw.

If soils are very sour, that is, if they are so sour that clover does not grow readily, from two to four tons of limestone should be applied per acre, at first. The county agricultural agent can give definite information regarding particular soils.

When to Apply.—Limestone may be applied at any time in the year with good results. A plan followed in some communities is to apply it on the frozen ground during the winter when work is slack. It may be applied on the wheat ground just before sowing time. It is best not to turn the limestone under by plowing when it is first applied, as, when this is done, the limestone does not affect the acid in the top layer of soil to any great extent, and this layer is the important one for crop growth.

Results from the Use of Lime.—The use of lime on soils which were very sour has more than doubled the former yield of clover; and, through the clover, has increased the yield of other crops. In 1918 the average wheat yields on ten experiment fields operated by the University of Illinois in the sour soil area were as follows:

Average Yields of Wheat on Ten Illinois Experiment Fields*

Plot 1	Plot 2	Plot 3
Nothing applied to the soil	Farm manure put on soil	Manure and limestone added to soil
1918—6.2 bu. wheat per acre	1918—8 bu. wheat per acre	1918—15.1 bu. wheat per acre

The yields given above represent the average yields of ten plots of ground located in different sections of Illinois where the soil was sour. Compare these yields with the yield of wheat on your home farm. These fields had been farmed by the University for different periods ranging from one to seven years, and crop rotation including legumes was practiced. The lime was very beneficial to the wheat crop, as may be seen from the results. The lime made the soil sweet and made it possible to grow clover, which when turned under enriched the soil for wheat. In 1918, the yields were not so great as in 1917, but the increase due to limestone is very evident. These same fields when treated with manure, limestone, and rock phosphate yielded 27 bushels in 1917, and 19.7 bushels in 1918, showing that when phosphate was used in addition to limestone even greater yields were possible.

Extent of the Use of Limestone.—When the necessity for more food products was made evident by the World War, farmers at once began to make every effort to increase production. The demand for limestone in areas where sour soil was limiting crop yields was so great that orders could not be filled. In some instances

* Illinois Experiment Station Circular 229.

single counties report that more than two hundred carloads of lime were used in a single season. Such facts tell us that farmers no longer believe that the farms will produce crops year after year without the use of fertilizers, and that farmers have learned the value of limestone. This material is rapidly becoming a necessity on the farm.

Review Exercises and Questions

1. Describe the action of limestone on sour soils.

2. What plants grow on sour soils? Do you find these plants growing in your community?

3. How much limestone would be required to cover the tillable soil on your father's farm, applying four tons per acre?

4. At $2 per ton, what would the above amount of lime cost?

5. A carload of lime contains about forty tons. How much can you haul with a team and wagon? How many loads would you have to haul to unload a carload? Could you unload a car in the two days allowed by railroad companies? Why do railroad companies allow the farmer only two days to unload a car?

6. In the experiment mentioned, limestone increased the wheat yield in 1917, 12.7 bushels per acre. At the present price of wheat, how much limestone at $2 per ton could be purchased with the increase?

7. Suppose your father owned land like the soil used in the experiment and grew one crop of wheat every three years. If no fertilizer is applied, how many bushels per acre will be obtained from the four crops of wheat grown during the next twelve years, if the yield is the same as that obtained in Plot 1 in 1918? What will be the value at current prices? If the land is treated with limestone and manure how much money will he receive per acre for the four crops, assuming the yield to be the same as on Plot 3 in 1918.

XII

CORN JUDGING

Home Work

Each pupil should carefully select a ten-ear sample of corn from the field or from the crib and bring it to school for judging purposes. Select the ears as nearly alike in shape, size, and color as is possible. The laboratory work to be done in corn judging will be done at school. There should be several samples on exhibit. Care should be taken not to shell off any of the kernels in handling the corn. The ears may be tied in a bundle and then wrapped to prevent the kernels from being shelled off as the sample is being carried to school. The sample should be labeled with a tag bearing your name.

Class Exercise

Aim.—The aim of the work in corn judging should be, not necessarily to become expert corn judges, but to learn to select seed corn more intelligently. You can probably get much help from the farmers in your community. At first, an ear of corn is likely to be just an ear of corn to most of you, much the same as a word is a word to the primary pupil before he has

learned to tell one from another and to see the differences between them. The work this month, however, furnishes a splendid opportunity for you to learn to see differences and variations in seed corn.

Value of Points.—Pads of score cards may be obtained from the school supply companies, or made up from the one on page 84. The score card is intended to be a guide to aid in the judging of corn, and the number of points given to each part are for comparison. Unless you keep this point in mind, you are likely to get the idea that the color of the corn is ten per cent of its total value. This is not true, as the ten per cent is assigned as a basis for comparison. The score card may be used as a guide, but the results which you get will depend entirely upon your ability to see the differences and to compare these differences fairly. The points on the score card may be divided into two groups. Breed characteristics are: color, type, shape, and size. Individual characteristics are: tips, butts, uniformity, space between rows and between kernels, percentage of corn, length, circumference, and *market condition.*

Study of the Ear.—Much attention should be given to the breed characteristics, since they are important in seed corn. Rules for applying the score card values may be found on the score card. Begin by studying an ear of corn, applying the points indicated on the score card to a single ear in order to fix the meaning of the terms and rules to be used in scoring corn. Each

pupil should select two ears of corn at random from samples on hand and, without any suggestion from the teacher, should list all the differences he is able to see. Classify these differences under the two heads mentioned in the preceding paragraph.

Type.—Special study of corn with regard to type is necessary for selecting seed. Type is determined by the character of the kernel, and the general make-up of the ear, some kernels being smooth and some rough in nature, while some are of different shapes. There is as much difference between an ear of corn having a rough kernel and an ear having a very smooth kernel as there is between a draft horse and a driving horse. A farmer usually makes up a team which is to draw the plow by using two horses of the draft type, and not by using one draft horse and one light driving horse, but most cribs of corn show corn of decidedly different types. Pick out ears representing various types of corn. Visit cribs or bring reports on cribs at home, showing the various types of corn. Note that there can be no "uniformity" of samples unless there is but one type.

Color.—Color in itself does not affect the food value of corn very much, if at all. Color is a breed earmark. Uniformity of color indicates careful selection, and food values and yield may be affected by selection. It is important then to have one color and to keep this color in mind in selecting seed. Note the various shades and combinations of color to be found in a single field or

crib where little attention has been paid to the selection of seed.*

Shape and Size.—Shape and size are breed characteristics which help to determine the yield, and yield is the big factor to be considered in the selection of seed corn. Compare a cylindrical ear with a pointed ear as to weight and percentage of corn on the cob by shelling the two ears and weighing the grain and cobs of each.

Uniformity of Tips and Butts.—Much attention should be given to uniformity of exhibit when scoring ten-ear samples, but beginners are likely to attach too much weight to the value of tips and butts when scoring corn. When seed corn has been selected with a great deal of attention to the way tips and butts are filled, ears may become shorter and smaller, thus reducing the yield. It is important then to select rugged ears. An ear with rows running straight to the tip, without the loss of any rows, although the tip may not be entirely covered, is preferable to an ear the tip of which is entirely covered, but which has kernels growing small and rows becoming crooked toward the tip.

Kernels.—Compare kernels of different shapes. Shell the corn from an ear having pointed kernels and from an ear having broad deep kernels, weigh corn and cob, and determine the percentage of corn on each ear. The shape of the kernel has much to do with germination

* NOTE TO TEACHER.—Some attention may be given here to the principle of plant breeding—"Like begets like." Present examples which illustrate this principle.

and the early growth of the seed. Corn with small pointed kernels may germinate, but its early growth will not be so vigorous as it would be if the kernel were larger. Plant seed of different shapes in boxes of moist

FIG. 19. KERNELS OF CORN SHOWING DIFFERENT SHAPES. NOTE SIZE OF GERM.

sand and record the time for germination of seed in each instance and note the early growth in each instance. The kernel has wrapped up within its coat the possibilities of the new corn plant, and this new plant will possess, in general, the earmarks of the mother plant that produced the grain. The only way to select seed corn is to go into the field and select the mother plants.

Corn Festival.—Arrange for a corn festival during the latter part of the month. Poems relating to corn, essays on corn selection, a demonstration of scoring corn, and a talk on types or uses of corn, may be included. A judging contest open to every one may be made a feature of the day. If possible, a corn show should be held. Obtain the services of disinterested persons who are competent to judge corn to award the ribbons or prizes.

A Score Card for Corn

Characters to be Judged	Points	1	2	3	4	5
1. Uniformity of exhibit	5					
2. Shape of ear	10					
3. Length of ear	10					
4. Circumfererence of ear	5					
5. Tips of ear	5					
6. Butts of ear	5					
7. Kernel—uniformity and shape	10					
8. Color of grain and cob	10					
9. Space between rows	5					
10. Space between kernels at cob	5					
11. Vitality or seed condition	10					
12. Trueness to type	10					
13. Proportion of corn to cob	10					
Total	100					

Your fathers and mothers should be invited to the festival in order that they may see the corn which is exhibited and may know something about the work you are doing while you are at school. Perhaps during the study period for English your teacher will allow you to write invitations to them.

A Score Card for Utility Corn

General Appearance 45%

Indentation 5

Ears with a distinctly rough indentation are frequently imperfectly matured owing to the presence of disease. Very rough indentation is objectionable and will be discriminated against.

Kernel Composition 5

Starchy seed ears produce many diseased plants which give unsatisfactory yields.

Shank Attachments 10

Many ears which have pink, slightly pink, brown, or shredded shank attachments were produced on diseased stalks. Frequently such ears may have an otherwise good appearance but whenever any of the above symptoms are found, the ear should be discarded. (Note: All ears must have the shank attachments intact just as the ear was broken from the shank. Any effort to trim out or alter the shank appearance will eliminate the sample from competition. This does not apply to ears which were stored on hangers.)

Tips of Ears 5

The tips of the ears should be bright and free from "weathering" or discoloration of any kind.

Luster or Polish 10

Ears having a bright, rather oily appearance have proved themselves superior as seed ears. This appearance indicates a normal, healthy development and complete maturity and is associated with greater vigor. Such ears possess higher yielding qualities than ears which are rather dull, dead or dry looking and which have no luster.

Kernel Characteristics 10

Kernels from normally matured healthy ears are nearly always thick, plump, bright, and clean, and possess well-developed germs. Such kernels usually have distinctly horny endosperm. A moldy or discolored condition of the kernels near the point of attachment to the cob indicates disease.

Germination Record 35%

Vitality and Vigor 20

The seedlings in the germination test should show thick, sturdy sprouts and good root development. Tall, slender, weak seedlings and those having short slender feeder roots are not desirable.

Freedom from Disease Symptoms 15

Type and Uniformity 20%

All ears in a sample should be uniform. The chief points considered here are shape and size of ear and uniformity of kernel. These vary with the variety and section of the state where the corn was grown.

Problems and Review Exercises

1. Ten ears of corn weigh seven pounds; the shelled corn from same weighs six pounds. Find per cent of corn and per cent of cob.

2. Yellow Dent corn should contain 88% of corn and 12% of cob. Find the standards for other varieties of corn. The legal standard for corn in the corn belt is 56 lb. per bushel for shelled corn and 70 lb. per bushel for ear corn. According to this standard, what is the per cent of corn and of cob? What are the legal standards of weight in your state?

3. A farmer has 40 acres of corn which yields 36 bushels per acre. How much will he receive for his crop if he sells it in the ear at 60 cents per bushel? If he sells it as shelled corn, assuming that the corn shells out 86% of corn? Will it pay him to shell if the shelling costs 1½ cents per bushel?

4. Find the capacity in bushels of a corn crib twenty feet long, eight feet wide, and eight feet high.

5. Find the dimensions of a crib large enough to contain the corn from the farm mentioned in problem 3.

6. What varieties of corn are grown in the community?

7. What variety yields best?

8. Why should the shape of ear be considered in judging corn?

9. Write a description of the best ten-ear sample of corn brought to the schoolhouse.

10. In what way will this exercise help you in your corn production? Discuss fully.

XIII

TESTING SEED CORN

Home Work

The Box Method.—Construct from boards one-half inch thick, a box 20 inches long and 20 inches wide. This size is a convenient one and allows ample space to test one hundred ears at one time.

Fill the boxes with sawdust or clean sand, almost level with the top of the box, thoroughly moistening the material with water. Mark off the surface into two-inch squares by making little furrows with a stick or lead pencil. Begin at one end of the box and make the first furrow or mark two inches from the end, and the second one two inches from the first. Follow the same method in making the furrows which mark the surface lengthwise. It is very important to mark off the surface with straight furrows in order to keep the kernels of corn in order later. The furrows can best be made straight by laying a yardstick across the top of the box as a guide.

The ears to be tested should be arranged in a definite order and kept in the same order until the test is finished. Place one hundred ears in a rack, or in rows on the floor or on a table. If the ears are kept in the

same order it should not be necessary to number them, but as a check it will be best to number the ears the first time by attaching a cardboard tag to the butt end of the cob with a pin or small nail.

Planting the Kernels.—Remove six kernels from each ear, two from a point about two inches from the tip, two

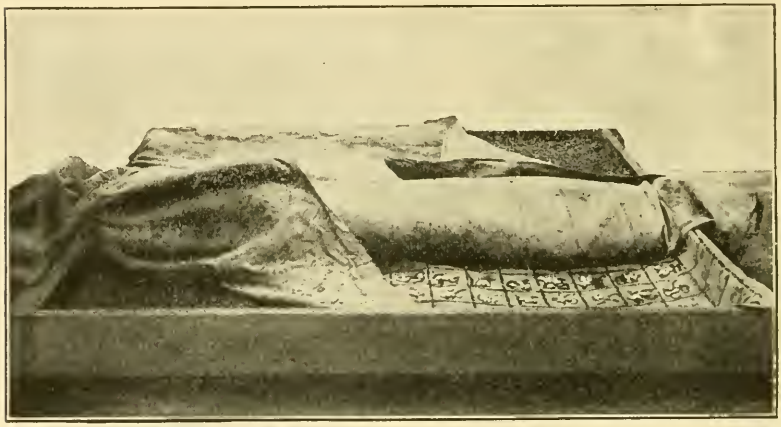
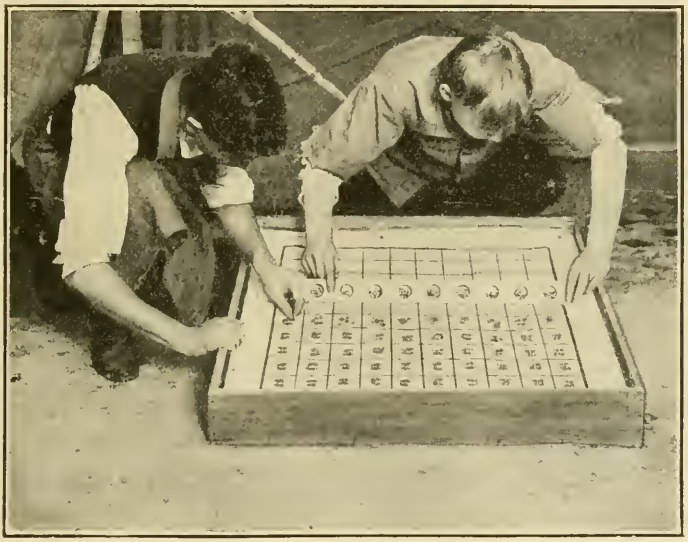


FIG. 20. A SAWDUST CORN TESTER

from a point about two inches from the butt, and two from the central portion of the ear. Begin with ear number one, and as soon as the kernels are removed, place them in the upper left-hand square of the seed box. Remove six kernels from ear number two and place them in the square to the right of the first. Continue in this way, beginning at the left of each row of squares. Mark the square containing the kernels from ear number one by placing a nail or stick in it. Thus when the

box is filled it contains kernels from one hundred ears and each square represents an ear. Cover all the kernels with sand or with a cloth. It may be that the marks in the sand will disappear, but when the kernels



Courtesy of Ginn & Co.

FIG. 21. PLACING KERNELS OF CORN IN A TESTING BOX

germinate it will be easy to distinguish the separate groups of kernels.

Keep the box in some place, such as the kitchen, where the temperature is warm most of the time. The boxes should not be allowed to become very cold or the germination may be checked.

Checking Results.—After five days count the number of kernels that have sprouted. If a kernel seem,

to be weak, do not count it as a good one. What percentage of the six hundred kernels in one box germinates? If one of the six kernels in a square fails to grow, it is an indication that other kernels on the ear from which it was taken are dead, also, and that ear should be discarded as being unfit for seed. What per cent of the ears do you find good for seed? How much time is required to test one hundred ears of corn? How soon do the first sprouts appear? Which bursts forth from the kernel first, the root or the stem? If ten per cent of the seed planted fails to grow, how many hills per acre will be missing on your farm? Test some of the kernels taken from the tips and butts of the ears and determine whether they grow as well as the more shapely kernels from the central portions. The germ lies on one side of the kernel and this side always faces in the same way. Does it face the tip of the ear or the butt of the ear? Count the number of rows on ten ears of corn and find whether there is an odd number of rows on any ear.

Facts to be Studied

Seed Should Be Tested.—The farmer who wishes to set out an orchard is careful to choose only those trees which are strong and healthy. It is not so easy to judge the vitality of seed corn by examining it; still the results which the farmer would get from poor seed are as truly unsatisfactory as those he would get if he set out a dead or diseased tree in the orchard. The only

way to know whether the seed will grow is to test each individual ear to determine not only whether the germs are alive or dead, but whether they are strong enough to make a vigorous growth. If a few kernels on the ear of corn show these good qualities, one may be reasonably sure that the other kernels will also grow.

Causes of Poor Seed.—Many different factors may cause the little kernels of corn to fail to produce satisfactory corn plants. Cold, wet weather weakens the germ or baby corn plant, sometimes causing the kernel to rot when corn is allowed to remain in the field too late in the season. Disease may attack the kernels in wet weather causing the germ to die or weaken. If the seed is kept in a moist room at warm temperature, the germs will start to grow and then die later on. Sometimes sprouts may be seen on some kernels at husking time. If a few kernels on the ear are beginning to sprout, the ear should be discarded because it is likely that other kernels have begun growth. Late maturity is perhaps the most common cause of poor seed. In the northern part of the corn area of the United States, early frosts frequently do much damage to the corn, reducing the feeding value of the kernel as well as the vitality or life of the germ.

Testing.—The seed may be tested at odd times during the winter months when there is plenty of free time on the farm. One method has been described in the directions for home work, but there are other

methods which may be more convenient for some persons. If a warm temperature can be provided, the corn may be tested by placing the kernels between pieces of blotting paper which are kept moist. This method requires more attention than the others be-

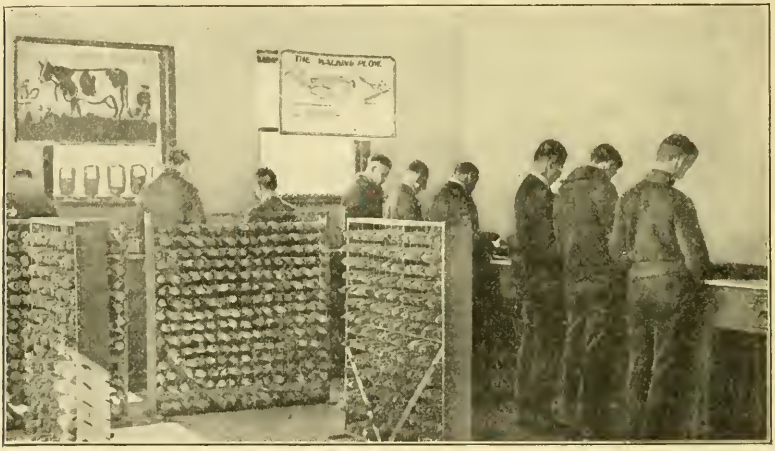
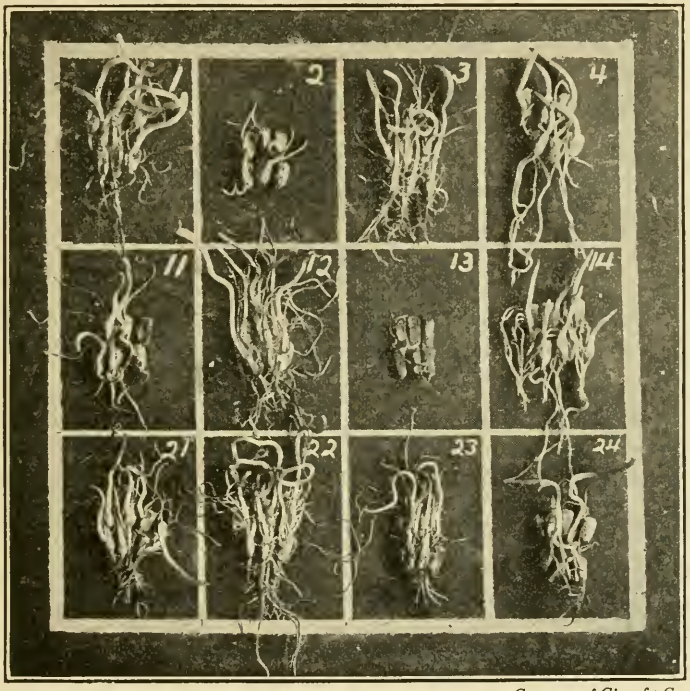


FIG. 22. HIGH SCHOOL BOYS TESTING SEED CORN. A CONVENIENT FORM OF SEED CORN RACK

cause the blotting paper dries out very rapidly unless it is covered with a wet cloth or placed between dinner plates.

Another device commonly used is the "rag doll." Heavy outing flannel cloth is cut into pieces about twenty inches wide and twenty-four inches long; then marked off in two-inch squares, and kernels placed in these squares. The sides of the cloth are turned in over the corn and rolled tightly from one end, thus

making a roll similar to a rag doll. The "doll" should then be soaked in warm water for at least ten hours and placed in a warm place to allow germination to go on.



Courtesy of Ginn & Co.

FIG. 23. SHOWING DIFFERENCE IN GERMINATING POWER OF SEED

The "doll" retains or holds the heat given off by the growing seed and low temperatures do not affect the test unless the temperature should drop to the freezing point.

Shelling Seed Corn.—After the corn has been tested and the bad ears discarded, it should be shelled, sacked,

and placed out of the reach of rats and mice. The kernels from the tips and butts are usually ill shaped and unfit for seed, not only because they are not likely to produce good strong plants, but because they will not pass through the openings in the edge drop planter. The tips and butts should be shelled off by hand and then the ears may be run through a hand sheller. Many farmers prefer to shell the corn by hand, thus making sure that no irregular kernels find their way into the seed sack.

Problems and Review Exercises

1. If you found ears that would not germinate what reason would you give for this weakness? Can you tell the exact cause of the weakness?

2. Make a "rag doll" tester in the school, fill it with kernels of corn, and note the growth from day to day. Make drawings in your notebooks showing seedlings five days after the seed has been placed in the "doll." Observe the root hairs on the young roots. What is the purpose of these hairs?

3. How many hills of corn are there in an acre if it is checked forty-two inches each way?

4. If a normal yield in your locality is forty bushels per acre, how many bushels will be lost on your farm if ten per cent of the kernels fail to grow? How many bushels would be lost on the total corn area of the farms represented in the class? How much money loss would this be at the current price of corn? How much time would have been required to test the corn for all the farms?

XIV

PLANT DISEASES

Home Work

Each boy will play the part of a doctor this week; and, if he can enlist the help of his father in this exercise, much good will result. The suggested exercise should become a farm practice. It is too much to ask a boy to do all the work, so it will be necessary to take the father into partnership.

Two exercises may be performed:

1. Treating oats for smut.
2. Treating seed potatoes for scab.

Directions.—Purchase two quarts of formaldehyde at the drug store. The seed oats should be piled in a heap on a clean floor of the granary or barn. Mix one pound of formaldehyde (40% solution) in 40 gallons of water and wet the oats thoroughly with this solution. One or two persons should turn the oats with a shovel while another sprinkles the solution from a sprinkling can. It will require about one gallon of solution for a bushel of oats. When the oats are wet, cover the heap with a horse blanket or other cover. This is necessary to keep the penetrating fumes in the oats. Allow to stand a few hours, in order that the evaporating formal-

dehyde may get through all the grain. The oats may be kept covered over night. Spread the seed and allow to dry before placing in the seeder. Oats should not be put back into the same bin after they have been treated as they may become infected again. They may be placed in clean sacks or placed in a wagon bed to be taken to the field.

The same solution may be used to treat seed potatoes for scab. Place the potatoes in a sack and put them in a tub of the solution for two or three hours. Then allow them to dry before planting. Instead of formaldehyde one pint of corrosive sublimate in 30 gallons of water, may be used.

If each boy will carry out these two exercises, hundreds of dollars may be saved in the two crops. The exercises are not difficult. The reason they are not practiced more widely is the fact that farmers just do not "get started."

Describe the scab which is found on potatoes. Have you seen heads of oats affected with smut? If so, what effect did the smut have? How does blight affect pear trees? Can you name other plant diseases and tell what effect they have?

Facts to be Studied

Damage by Disease.—Plants are living things just as animals are, and are subject to disease and destruction in the same way that animals are. Much grain is lost each year by disease, the estimated annual loss in the

United States due to plant disease being more than a billion dollars. A disease which "broke out" in wheat fields in a few counties near St. Louis, Missouri, in 1919 destroyed more than a million dollars worth of wheat.

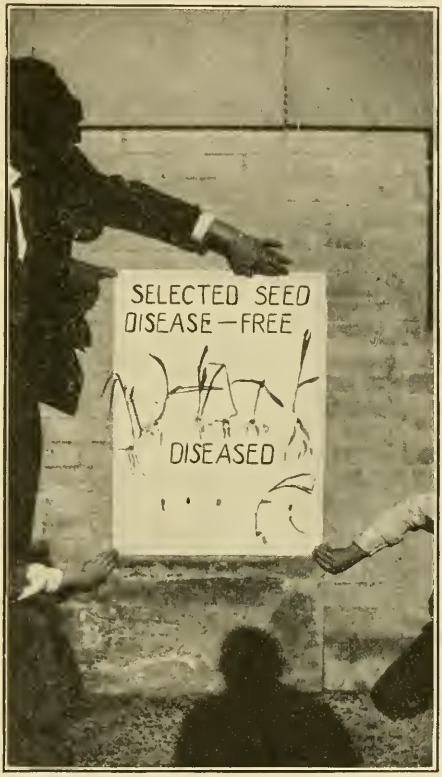


FIG. 24. GERMINATING POWER OF SEED CORN—MURPHYSBORO, ILLINOIS, HIGH SCHOOL.

Fungus Disease.—A type of plant disease commonly found among economic crops is the fungus. Oats smut is a typical fungus and may be described as an illustration. The smut may be said to be a plant growing upon a plant. It is true that the plants we call smut are so small that they can scarcely be seen with the naked eye except in bunches. Nevertheless, the tiny forms of plants have a minute root system and a slender stem. On the thread-like stem grows a little black ball which bears thousands of microscopic seeds or spores as

they are called. Can you imagine a grain of oats covered with tiny plants all stealing the sap and food from the grain. It does not take long for the smut to devour or destroy completely the grain of oats. Stalks of oats infected with smut often do not contain a single good grain; the smut has destroyed the grain just as mold softens and destroys a piece of bread. The roots of the tiny smut plants fasten themselves in the kernel of oats just as the roots of the tree grow in the soil.

How Fungus Spreads.—Most diseases of plants are "catching." These tiny growths spread from stalk to stalk and even from field to field in much the same way that dandelions and milk weeds spread. The tiny spores are easily blown by the wind from place to place and wherever they lodge they become so numerous that they can soon destroy a field of oats. The author has counted stalks of oats infected with smut and found more than 50% of the stalks in a given area without any good grains of oats.

The Treatment.—The treatment advised in the directions for home work is the same as disinfecting a house after sickness. The formaldehyde gas kills the tiny spores so that they will no longer grow and produce more smut. If the field is not already infected with the disease, the crop is not likely to be damaged. The spores may "live over" in the soil and because of this fact crop rotation should be practiced. This is advised particularly in growing potatoes where scab has been found, as the scab may live over for more than one year in the soil.

Other Kinds of Diseases.—Besides the fungus diseases, there are some others which are more nearly like the diseases to which people are subject. Some are caused by bacteria or "germs" as they are sometimes called, pear blight being an example of such a disease. Sometimes plants just seem to be "run down" and in such cases we say they have a constitutional disease.

Preventives.—One important preventive is to sow seed from healthy plants. Some varieties of plants have been developed which resist disease more than others. A tomato has been developed which seems to resist one of the common tomato diseases. Some varieties of wheat resist rust and smut more than other varieties.

If crops are changed from year to year, the disease is not likely to stay in the soil. People hesitate to move into houses where tubercular persons have lived because the germs of this disease are likely to be there. Just so, people should not plant potatoes in a field where scab has been found because the spores are still in the soil.

Other diseases are:

Stinking and loose smut of wheat.
Rust and scab of wheat.
Potato scab.
Leaf rust and stem rust of oats.
Pear blight.
Apple blotch.
Corn smut.
Ear rots of corn.
Apple scab.

Problems and Review Exercises

1. What is a plant disease?
2. Describe a fungus growth or disease.
3. Name ten diseases of plants.
4. Give the method of controlling smut in oats.
5. How does potato scab differ from smut?
6. Write the "prescription" for curing these two diseases.
7. To what extent do plant diseases destroy crops each year?
8. What is formaldehyde? How does it affect the diseases mentioned?
9. How may fungus diseases be carried from one plant to another?
10. In one county, the county agricultural agent kept records as to the oats which were treated and those which were not treated. The oats which were treated for smut yielded six bushels more per acre than those untreated. The record was kept on 5,000 acres. If all seed planted on the 5,000 acres had been treated, what would have been the gain due to treatment? At 50 cents per bushel what would the farmers have gained for their labor in treating the oats for smut?
11. Can you give examples from your community showing the value of treating seed for disease?

XV

PRUNING

Home Work

Old and New Canes.—Select a currant bush and a gooseberry bush in your home garden. Count the number of canes or cane stems growing from the root crown. How many grew during the last season? Name all the earmarks by which you can tell the old canes from the young ones. Count the buds on some canes of the last season's growth and compare them with the buds on one of the oldest canes in number and size. In pruning, mark each kind of cane so that you will be able to compare the fruit yields during the coming season. Compare some of the old canes found in the raspberry or blackberry bushes with the new ones which are to produce fruit the coming season and list the differences which you can see between the two kinds of canes.

The Grapevine.—Make a study of a grapevine. On what parts of the vines do you find buds most abundant? Can you tell the newest shoots or canes from the oldest ones? Measure the longest grapevines you can find. Count the different years' growth, as nearly as possible, to determine the age of the vines. Each

year's growth is marked by a curved joint where a "shoot" has grown from another cane.

Apple Trees.—Observe apple trees to find the different shapes of tops. They range from the very round

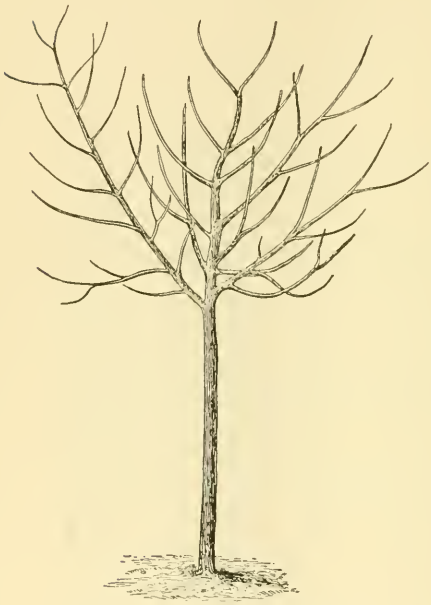


FIG. 25. A YOUNG APPLE TREE BEFORE PRUNING.

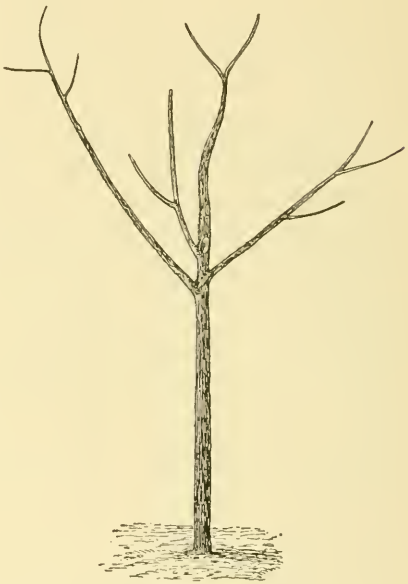


FIG. 26. SAME TREE AFTER PRUNING.

to the upright or peaked form. How far from the ground are the base limbs of the highest heads? Of the lowest? Does the trunk of the tree from the ground to the first limbs ever grow longer or do the first limbs always remain the same distance from the ground?

Can you suggest reasons for your answer? What does your answer suggest about pruning a young tree?

Select a small tree and ask your father or someone on the farm to help you prune it. Have your knife, shears, and saw sharp. Use a step-ladder to reach the limbs, as it is not desirable to climb on the limbs. Cut out all dead or diseased branches. Make all cuts close to the main trunk or branches and make the cuts smooth. If the limbs are large, cover the wound with paint to prevent decay and insect damage. Thin the top by cutting out crooked branches and branches that have grown across each other. Try to make the top of the tree look shapely by your work and cut out enough of the branches to allow the sunlight to reach the inner parts of the top. In cutting the ends of branches leave a bud just below the cut to start a new branch.

Note the illustration showing how to prune a young tree. If there are no young trees on the farm, prune an old tree. This will require more work but it will be worth the effort, as better quality of fruit will probably result.

Shrubs.—The class should prune the shrubs in the school yard. Ornamental shrubs may be pruned any time after flowering time, the usual time being early spring. The main object is to make them more shapely and to stimulate growth. Shrubs which are not pruned soon become rough and uneven in growth, making a less pleasing appearance than well pruned shrubs. The older branches should be cut out, keeping the younger

growths from year to year. The size should be controlled to suit the surroundings. For instance, barberry about the porch or entrance should be kept below three feet in height. Each boy should prune the shrubs such as lilacs and honeysuckle growing in the home yards. Perhaps more work is outlined than one boy can do, but each should choose the piece of home work which needs most to be done.

FIG. 27. A TWENTY-FIVE YEAR OLD LILAC BUSH WHICH HAS NEVER BEEN PRUNED EXCEPT BY NATURE. NOTE THE MASS OF STRUGGLING YOUNG GROWTH.

FACTS TO BE STUDIED

What Is Pruning?—Pruning means trimming or cutting away some parts of a plant. Nature prunes the trees of the forest when she causes the wind and storm to break off limbs that are dead. Every boy has seen trees in the orchard or street that have had the knife and saw used on them until nothing is left but the

trunks and stubs of the main branches. Such wholesale cutting is usually not intelligent pruning, but a cutting back without a purposeful aim. There are those who say that pruning is unnecessary because Nature intends all growth for some good; but we must remember that the apple tree, if allowed to grow in the wild and natural surroundings of the forest, does not produce the large, juicy fruit which is so relished by man, but instead, produces a small sour product. The purpose of the fruit tree in bearing fruit is to reproduce the kind by scattering seed and not to produce food for man, and it is only when man cultivates the tree and directs its growth that good fruit can be produced. It is true that some delicious fruit, such as the blueberry, dewberry, and other similar fruits, may be found growing wild, but these are exceptions and they too can be improved by pruning and cultivation.

Why Prune?—The trees grow more branches from year to year and soon the inside branches are so shut in that the sunlight cannot reach them. When some of the branches are cut away, the others will get more food and sunlight and will thrive better. The branches thus cared for will produce better fruit than they would have produced if they had been crowded and shut away from the sunlight. Sometimes branches become diseased or are injured by a storm. If allowed to remain on the tree, such branches will spread disease and finally cause the death of the whole tree. It is neces-

sary that they be cut off. Sometimes a man's hand is crushed in some piece of machinery or it becomes infected with blood poisoning, and the surgeon finds he cannot stop the poison or save the hand by medicine, so he cuts off the hand in order to save the life of the man. It is not a difficult task for boys to find the diseased portions of shrubs and trees about the home, and many trees and shrubs may be saved by cutting out diseased parts.

Another object of pruning is to keep the shrubs and trees within certain limits of size and shape. Pruning for this purpose is practiced on the flowering shrubs and sometimes on fruit trees and shade trees.

The fruit grower prunes regularly to increase the quality of fruit borne on his trees. There are several ways in which pruning aids fruit production. The tree is made more healthy and vigorous by cutting off the diseased and broken branches; more sunlight can reach the inner branches if the head has been thinned by pruning; not so much disease will be found in clean, open fruit trees as is found in the ones which are thickly branched; and the fruit will grow larger if not crowded. We know that the roots take up water and food from the soil and carry the materials up to the leaves where the food is made over and used in the growth of the tree. If some of the branches are cut off, there will be more food for the ones remaining and they will develop a more vigorous growth, thus producing a better quality of fruit.

How to Make the Cut in Pruning.—Much depends upon the way a limb is cut. If it is chopped off or broken off, a ragged surface will be left and disease will affect it later. A "clean cut" on the finger is not so dangerous as a ragged and torn wound made by tearing the flesh, because there is more danger of infection in the latter case. The same is true of tree wounds. The cut should not only leave a smooth surface, but should be made close to the main stem or branch as shown in the illustration. Long stubs are liable to become harbors for insects and disease.

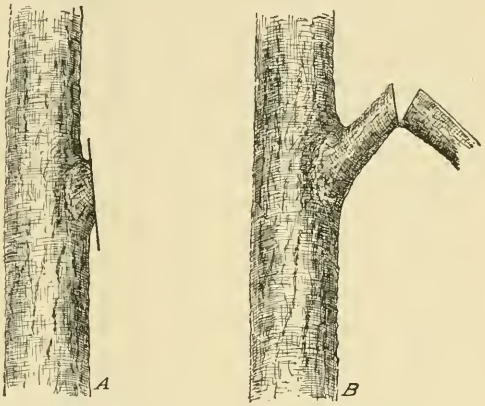


FIG. 28. METHODS OF CUTTING OFF BRANCHES: *A*. CORRECT WAY; *B*. INCORRECT WAY

Pruning Young Trees and Shrubs.—Directions have already been given for pruning trees as they are set. Young shrubs and trees should be pruned regularly during their early life, the pruning being particularly important at this time because on it depends the shape of the shrub or tree. Young fruit trees should be pruned so as to form a well-balanced *head*, beginning at the proper height from the ground.

Shrubs, such as the barberry, lilac, and bridal wreath, are more beautiful and develop better if they are pruned and not allowed to grow as in the wild state. A more vigorous growth will be obtained if the young shrubs and trees are pruned severely. One of the authors planted a yard with shrubs. When he began to cut them back rather severely the owner objected, saying that she was sure the shrubs would die if cut so severely and that she could not bear to see such "merciless surgery." He saw the garden each year for several years and the shrubs that had been properly cut back made an excellent initial growth and none died. But not so with the unpruned specimens; they became ragged and the growth was much less vigorous. Leaf growth is more luxurious on pruned trees and shrubs.

Pruning Bush Fruits.—Blackberries are produced upon canes or branches that die as soon as the fruit is borne, a new set growing each year to bear fruit the following year. Raspberries and dewberries are similar in their habits. There are three main things to do in pruning such bush fruits as blackberries. First, the old or dead canes should be removed when they are through bearing fruit. This may be done by cutting off the dead canes at the ground or the crown of the roots, using ordinary pruning shears or a pruning knife. The second process is to pinch back the growing shoot or cane which is to produce the fruit frequently during the growing season, pinching off the tips with the thumb and finger, or clipping them with a shears.

When the end is thus cut off, the cane stops its upward growth and begins to throw out branches along the side of the cane, which branches sometimes grow so long that they too need pinching back. If careful attention is given to the berry patch during the growing season, the quality of fruit will be much improved and the work of harvesting will be greatly lessened. Third, some of the growing shoots should be removed from the plant during the growing season by cutting them off at the root crown. This process is important as berry bushes usually send up too many canes to produce a good

Courtesy Illinois Agricultural Experiment Station.

FIG. 29. GOOSEBERRY CANE BEFORE PRUNING, SHOWING OVER-ABUNDANCE OF GROWTH

Courtesy Illinois Agricultural Experiment Station.

FIG. 30. SAME CANE AFTER PRUNING

quality of fruit. From a half dozen to a dozen sturdy canes should be allowed to remain in each hill. Most of this pruning can be done easily by boys; in fact, boys can do the work to better advantage than can men because they are more nimble and can stoop to cut the canes with less effort than can grown men. One of the authors, when a boy, found the pinching back of an acre of blackberries a most interesting process. To be able to check longitudinal growth of the cane and to cause it to become a real bush by putting out the lateral branches is a most important as well as an interesting part of growing the fruits; and it can be done merely by pinching off the growing tip. When a person picks from forty to sixty quarts of blackberries or raspberries in a day he will appreciate the importance of having low, well-formed, well-branched canes which stand apart from others in the same hill. The canes should be about two feet high and thinned so that one will not interfere with the other. Raspberry vines or canes are inclined to grow beyond control if not pinched back or severely pruned. The long canes bend over and lie on the ground, causing the fruit to spoil, while if properly pruned, they remain upright as do blackberries. Sometimes a wire trellis or stake is used as a support for raspberries.

Gooseberries and Currants.—Perhaps a large majority of the "bushes" which are to be found in farmers' gardens are allowed to grow from year to year with very little attention, bearing fruit of such quantity and

quality as they can under natural conditions. However, a little attention to such plants as currants and gooseberries will be worth while. The woody stems or canes more than three years old should be cut out and the new growth should be kept thinned. Some new canes should be encouraged each year in order to keep a supply of young growth at all times. Any diseased wood or stems infested with insects should be burned. In fact, a good rule to follow in all pruning work is to burn all parts cut off, as they may become infected with disease while they lie on the ground, even though healthy when cut off.

Grapes.—Since grape pruning is somewhat different from the pruning of the bush fruits a few suggestions for their care will be given. There is danger of allowing vines to produce too much vegetation; that is, leaf and stem growth which will reduce the amount of fruit. Farmers are likely to be more interested in having the grapevines cover an arbor for purposes of shade than they are in obtaining fruit production. The grapevines should not be expected to give us a good shade or arbor covering and at the same time produce the best quality of fruit. They require severe pruning. Many systems of pruning and training grapes are in use. These systems may be found illustrated in books on fruit growing. The main points or facts to be learned are similar in all systems. Grapes are produced on shoots which grow from buds on last year's growth. A cane which grows this year will develop buds in the

summer and these buds put out shoots next year, grapes being borne on the shoots. One of these shoots, the one nearest the last year's cane, should not be allowed to bear fruit. It is kept for the purpose of producing shoots the following year. All fruiting shoots except the ones saved to produce next year's shoots should be cut off at the end of the fruiting season. The shoot or cane which remains should then be cut back to the number of buds desired and trained to a wire trellis. A good vine may support a dozen or more canes, each bearing as many as fifteen to twenty buds. The illustration shows one method of cutting back the grape.

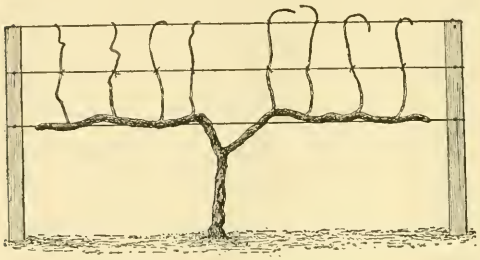


FIG. 31. ONE METHOD OF PRUNING AND TRAINING GRAPEVINES

Grapes should be pruned during the dormant period, that is, the period when the vines are resting. Most pruning is done in winter when the sap is not flowing.

Summary.—We have said that pruning with the shears or knife is just a way of helping Nature to do her work in thinning the branches on a tree or shrub and in taking out the broken and diseased branches. Pruning gives ventilation and sunlight to the inner part of the tree head. It stimulates fruit production, and

wood production as well, depending upon the time when the work is done and the method used. In general the dormant, or sleeping period, of the plant's life is the best time to prune, although for some purposes summer pruning may be practiced. Methods of pruning should be adapted to the particular kinds of trees or shrubs which are to be pruned. The grape requires one method or type, the blackberry another. To train the plant to a certain form or size it is necessary to start as soon as the plant is set. Boys can be of great service on the farm by coöperating with their fathers in making every tree and shrub in the fruit garden do the best it can in the production of fruit for the table. It will be fun to clean out the old gooseberry bush and make it over into a new and thrifty bush which will produce better berries than it ever produced before.

Problems and Review Exercises

1. What kinds of fruit trees and bush fruits which should be pruned have you on your farm?
2. Describe the methods used in pruning the plants on your farm.
3. How could you improve upon these methods?
4. Bring a branch of an apple tree to school and show the class how to make the cut in removing branches.
5. Why should young trees or shrubs be pruned soon after they are set?
6. Find out all the different methods of pruning used by farmers in your community.
7. How can you tell wood one year old from older wood?

8. How does pruning aid in making the quality of fruit better?

9. Tell how you pruned a single tree, shrub, or bush.

10. How does the method of pruning the grapevine differ from other types of pruning. Bring a part of a grapevine to class for illustrative pruning.

XVI

THE HOTBED

Home Work

How many farmers in your community use hotbeds? This question may be answered if a coöperative survey is carried on by the class. Very little time will be needed for this part of the study, the purpose being to determine what is the general practice in the community.

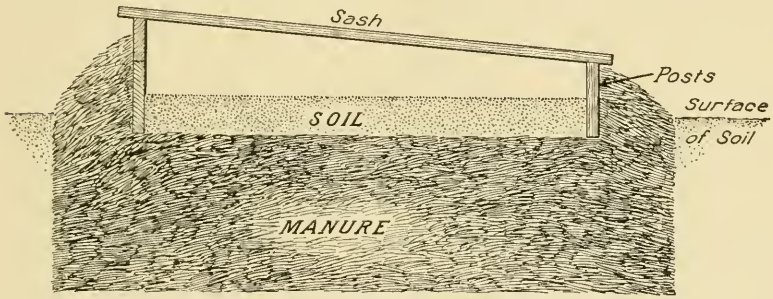


Fig. 32. Cross-section of manure pit hotbed

The main work to be done at home is to make a small hotbed, or to help to construct a large hotbed if needed on the farm. Specific directions will be found in the next part of this chapter. The hotbed should be made as cheaply as possible, keeping in mind, of course, that

it should be made sufficiently large and durable to meet the demands of the family garden this year.

It will be a good plan for the class to build a small hotbed at the schoolhouse following the directions given by the teacher. Flowers for the school may be started, such as asters, salvia, snapdragons, and ornamental grass. If it is not desirable to plant flower beds on the school grounds, these plants may be reset in paper pots or strawberry boxes and taken home by the pupils.

The first hotbed to be made at home may be made to fit an old window sash, which may be found on the farm.

Seed should be planted in the bed soon after it becomes warm.

Write a story for your language lesson telling how you made your hotbed.

Facts to be Studied

Purpose of Hotbed.—A hotbed is a bed of soil which is artificially heated. It is used as a place to start plants for the garden. In all central and northern regions there are many plants which require a longer season to reach maturity than the climate allows. Such plants should be started early and transplanted as soon as the weather permits.

Kinds of Hotbeds.—There are several ways of heating hotbeds, steam pipes sometimes being extended through the bed of soil where large hotbeds are needed and steam is available. The most common type of hotbed

is one heated by horse manure, which gives off heat when it ferments. There are two types of this kind of hotbed: one, which is built entirely on top of the ground, called a surface hotbed, and the pit hotbed in which the manure is placed in a pit dug in the ground. The latter is the best kind for us to build, especially in the colder climates. The pit, which should usually be about a foot deep, is filled with manure and the frame is set a little above the level of the ground in order to secure good drainage.

Where to Place the Hotbed.—Every boy has at some time "visited" with the "gang" on the south side of the barn or shed and knows how much warmer it is on this side where the sun's heat is reflected than it is out in the open or on the north side. Since the purpose of the hotbed is to supply heat to the young seedlings, the bed should be placed on the south side of a building, a wall, or a high board fence. The place should be well drained and slope to the south. If natural drainage cannot be secured, a trench should be dug to allow the excess water to run away.

The Pit.—The pit should be made at least a foot deep and should be made a little larger than the hotbed frame in order to secure heat at the edge of the soil bed. Sometimes the ground is frozen at the time when the hotbed should be made, and it is difficult to dig the pit. The freezing may be prevented by covering the place with horse manure to a depth of one or two feet, some time in January, or at least two weeks before you wish to make the hotbed.

The Frame.—The frame should be made of twelve-inch boards, boards two inches thick being best for this purpose. The frame should be set in the pit so that it has a pitch to the south of about an inch to the foot, and should be supported by a post or stake at each corner, otherwise it may settle out of shape when placed on the manure.

The Sash.—The regular hotbed sash is made of small panes of glass, and is usually about 3 feet by 6 feet in size; but any sized sash may be used.

The glass should be overlapped so as to drain the water off to the south. However, an ordinary window sash containing from four to eight panes can be used if not convenient to get a regular hotbed sash, if the partitions are notched to allow the water to drain off. It is best to hinge the sash at the north end of the frame.

Making the Bed.—Fill the pit with fresh, unfermented horse manure which should be well tramped in the pit. It is better to have the manure piled up a week or two before placing it in the pit, but care should be taken that it does not burn during this time. Manure should be banked around the outside of the frame, to aid in retaining the heat.

When the manure has been placed in the pit, about 6 inches of fine, loose, mellow soil should be placed in the frame on the manure. It is difficult to get this soil when the ground is frozen and for this reason it is well to use soil which has been covered with manure for a week or two. When the soil has been placed in the

frame, the hotbed is finished. It should not be allowed to become too dry during the next two weeks, while it is heating.

When to Plant.—It is a mistake to plant seeds in the hotbed as soon as it is finished as the bed is likely to become too hot during the first week or two, but seeds may be planted as soon as the temperature becomes regulated from 70° to 80° F. The bed should be ventilated, but should not be allowed to get too cold for seed germination. Plenty of fresh air and moisture should be supplied, as the young seedlings are beginning to grow. It is well to make daily observations of the temperature as the hotbed is warming up.

Problems and Review Exercises

1. What is the purpose of the hotbed? The cold frame?
2. Tell how to construct a pit hotbed.
3. Record the highest temperature in your hotbed during the first week.
4. What is the difference between the pit and surface types of hotbeds?
5. Name five advantages of the hotbed.
6. Find the cost of a hotbed 3 feet by 6 feet at local prices.

1 sash 3′ x 6′	Labor—8 hours
1 pair hinges	Lumber:
1 load manure	3 pieces 1′ x 2″ x 6′
	4 stakes 2″ x 4″ x 2′

7. What plants must be started in the hotbed in your community?
8. What other plants might be started in the hotbed with profit?

XVII

TRANSPLANTING PLANTS

Home Work

The principles and processes of transplanting can be well illustrated in the transplanting of tomato plants. The home work in connection with this study should cover several weeks' time. Our object is to grow tomato plants until they are ready to be set in the garden, studying the reasons and principles underlying the processes used in connection with transplanting.

Choose the variety or kind which you will plant in the home garden and get the seed in January. Such early varieties as Bonnie Best and such later varieties as Stone, Ponderosa, and Grand Pacific give good results.

The seeds may be planted in a small box of fine, loose soil in the house or they may be planted in a hotbed. If planted in a house box, plenty of moisture should be supplied, and the box should be drained. Place the box in a warm light window. When the young seedlings are from two to three inches high, they should be transplanted to two-inch flower pots. If flower pots are not available, small tin cans will answer the purpose

if holes are punched in the cans to provide drainage. It is best not to transplant to larger pots at first. The tiny plants should be handled carefully in order not to break the roots. The stem is easily broken. Make a hole in the soil with a stick or pencil and drop the plant into it, packing the soil around it.

When the roots have completely filled the two-inch pots, the plants should be transplanted to larger pots, strawberry boxes being very good substitutes for flower pots. By tapping the small two-inch pots on a hard surface, the plant will come out without breaking up the mass of roots, and if transplanted to larger pots in this condition, the plant continues its growth, not being retarded by the shock which would ordinarily occur in transplanting. The plants should not be kept too warm or they will become spindling. The best place for the larger pots or strawberry boxes is in a cold frame on the south side of a building where they may be protected from freezing weather. If there is likely to be much cold weather, the pots may be kept in the hotbed under glass.

When the plants are almost ready to bloom, they may be transferred to the open garden, being transplanted as soon as there is no longer any danger from frosts. To transplant into the garden soil, make holes large enough to contain the entire root system and soil as it comes from the pot and set the plant a few inches deeper than it was in the pot. The plant should not wilt if properly set.

Facts to be Studied

Necessity of Transplanting.—Transplanting is necessary in parts of the country where the growing season is too short to grow and mature the garden products needed. If the season is shorter than the length of time required for maturity, then the plants must be grown in hotbeds for a short time, before they are placed in the garden. In northern and central regions, such plants as cabbage, head lettuce, cauliflower, celery, tomatoes, eggplant, sweet potatoes, and peppers must be started under artificial conditions because the frost catches them before they mature if the seed is sown in the garden after the soil becomes warm. Time and expense are required to grow plants and transplant them, but machines built for transplanting plants on a large scale have lessened both labor and cost. The hotbed has been described in detail in Chapter XVI, but it may be noted here that the hotbed should be made early enough to allow plenty of time for plants to develop, the particular time varying with the locality. Celery, eggplant, and tomatoes require more time for development in the hotbed than cabbage, cauliflower, and lettuce.

The methods of successive transplanting from one place to another have been described in the directions for home work. Most plants do not require the successive transfers that are recommended for tomatoes.

Watering Plants.—We have already learned that plants take up water through the roots, and that the

water enters the roots through the root hairs. When transplanting plants from the hotbed to open fields, it is often impossible to keep from injuring the root hairs, so the plant must grow new roots before it is able to attach itself to soil particles and to take in moisture in the regular way. The plant, however, adjusts itself very rapidly and within a few days' time the new root hairs may be seen growing if the plant is again pulled from the soil. In the meantime, the plant needs plenty of water to keep it from wilting, so when plants are being set by hand in the garden, water should be poured into the hole before the plant is set. It is a mistake to pour water on top of the soil about the plant for it makes the soil pack and evaporation goes on more rapidly. Sometimes, if the sun is very hot, it is advisable to cover the plants with paper or large leaves, such as may be obtained from rhubarb, in order to check excessive evaporation through the leaves. Potted plants do not need such precautionary care because the roots are not disturbed when the plant is reset.

What to Grow for the Flower Bed.—Many flowering plants can be grown most successfully if started in the hotbed. Every one admires the beautiful asters which bloom in late summer and fall. These plants should be started in February or March and transplanted to little pots or to flats (shallow boxes filled with soil), but should not be transplanted to the open bed until warm weather. Salvia is another plant which grows through a long season. The blood red appearance which a bed of salvia takes on in the late summer

is enough reward to repay any boy or girl for growing and caring for the plants early in the season. The seeds are planted at the same time that aster seeds are planted and the plants are transplanted in the same way.

Snapdragons do best if transplanted. They bloom in the summer and continue to bloom until late autumn if the plants are sturdy. Many other plants, including such house plants as the geranium, must be transplanted to give the best results. The latter is started, however, not from seed, but from cuttings placed in small pots.

Problems and Review Exercises

1. What is meant by transplanting?
2. Why is transplanting necessary? Is it necessary in all localities? Is it necessary for all plants in your locality?
3. What are root hairs? Why are root hairs mentioned in connection with transplanting?
4. State the general principles which you have learned in connection with transplanting. Give reasons for each step.
5. Describe in detail just what you would do in watering a plant. Give reasons for these directions.
6. How do plants take in water?
7. How is water given off?
8. When should the various plants be started in the house or hotbed? Make up a planting table for your locality, showing when the various plants may be planted in the garden.
9. Suppose you were growing head lettuce by starting the plants in the hotbed. Outline the things to be done in order to make the transplanting successful.
10. How does the procedure followed with lettuce differ from that followed with tomatoes?

XVIII

THE HOME VEGETABLE GARDEN

Home Work

Each member of the class should arrange to have a small garden at home for which he is entirely responsible. Other home work may be done as suggested; but the small garden described in the following plan should be grown and accounts should be kept through the summer. Much pleasure may be found in planning, planting, and caring for such a garden which should be small so as to insure the best of care and good results. The dates suggested in the directions for planting are for the central section latitude about 40° and the dates should be changed to meet climatic conditions in your community.

Arrange an account book to show the following data:

Vegetable	Date Planted	First Plants Appeared	First Plants Ready for Use	Amount Harvested	Total Value	Remarks

THE PLAN

10 feet x 30 feet

1. Parsnips
2. Parsnips
3. Chard
4. Lettuce
5. Radishes
6. Peas
7. Peas
8. Onions
9. Onions
10. Beets
11. Carrots
12. Head Lettuce
13. Head Lettuce
14. Cabbage
15.
16. Cabbage
17.
18. Beans
19.
20. Beans
21.
22. Beans
23.
24. Tomatoes
25.
26. Tomatoes
27.
28. Tomatoes
29.
30.

The garden should be at least as large as the one shown in the plan. The numbered rows are twelve inches apart, but rows 15, 17, 19, 21, 23, 25, 27, 29, and 30 should be left vacant and the space given to the next row. The rows of cabbages, beans, and tomatoes

should be set at least two feet apart. The beans may be drilled in the rows. The cabbages should be set eighteen inches apart in the row and the tomatoes should be set so that each plant will have about ten square feet.

Planting Directions for Home Garden

The Parsnip.—The parsnip is a root crop; that is, the root is the portion which is used for food. The seed should be sown in the garden about April 15th and as soon as the plants are large enough, they should be thinned out to about two or three inches in the row. They will then grow through the summer and finish their growth in late fall. Parsnips are thought to be better for table purposes after they have had a light freeze. They may be left in the soil until spring or may be taken up and laid away in the cellar or buried in a pit in the garden until they are wanted for the table.

Chard.—Chard belongs to the beet family and should be planted at the same time that parsnips are. It produces a luxuriant growth early and is ready for cooking as soon as the leaves are large enough to use. The stalk may be used in the same way as asparagus and the leaves as greens. It will make a new growth as soon as the leaves are cut, thus furnishing greens throughout the season. The seed should be drilled in the row and as soon as the plants are large enough they should be thinned out to three or four inches in the row.

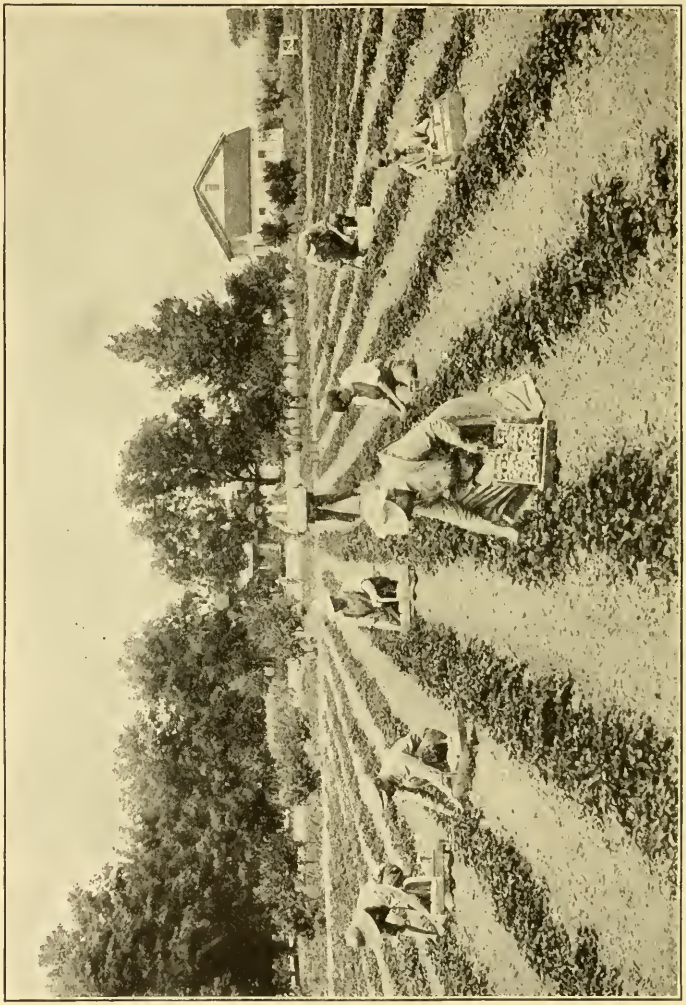


FIG. 33. PICKING STRAWBERRIES. THERE IS PROFIT IN SUCH A PROJECT AS THIS.

Leaf Lettuce.—Leaf lettuce should be sown as early as the soil is ready to be worked in the spring. The seed should be sown rather thickly in the row and thinning may be done when the plants are large enough to use by pulling whole plants from the soil. Lettuce is a cool season crop; that is, it grows best in cool weather, becoming bitter in hot weather.

Radishes.—Radishes belong to the cool season crops as does lettuce and should be sown at the same time lettuce is sown. Later sowings should be made at intervals of ten days to furnish fresh roots for a longer time, as they get pithy soon after maturing and all the plants of one sowing usually mature at about the same time.

Peas.—Peas must have a cool season in which to develop so they should be drilled in rows as soon as the soil is ready to be worked. They require very little care other than weeding and keeping the ground loose to save the moisture.

Onions.—The onion sets should be planted about two inches apart in the row as soon as possible after the ground becomes warm. Lettuce, radishes, peas, and onions may be set out on or about April 1st in the central part of the United States.

Beets and Carrots.—Beets and carrots, like parsnips, are root crops. The seed may be drilled in rows at the same time that the parsnips and chard are planted. They will be ready for use in the early part of the summer and will not withstand frost as will the parsnips. Beets and carrots are best for table use when they are

quite young and tender but they may be used at any time during their period of growth.

Head Lettuce.—Head lettuce should be cared for in much the same way as early cabbage. The plants should be started early in March in the house or hotbed. It is better to grow the plants in the hotbed and transplant them to the cold frame so as to harden them before setting them in the soil. In the central part of the United States, they may be put into the soil as early as April 10th. The plants should be set about twelve inches apart in the row. They must be grown in the cool season and should be grown quickly if they are to make large, tender heads.

Cabbage.—Cabbage should be started in boxes and the plants may be set in the garden about April 15th. By that time they should be large, well-developed plants. The plants that have grown tall but have not developed a good root system may not withstand the shock of transplanting. When transplanting any variety of plant from hotbed or window box to the garden, it is important to have a good strong plant and well-prepared soil. Water should be put into the hole before the plant is set. There is little value and sometimes much damage to the plant when water is poured on the soil around the plant after transplanting. The plants must be watered from day to day for a few days after they are set in the garden, but the soil should be stirred around the plant after the water has gone into the soil.

Beans.—Beans belong to the warm season crops and should be drilled in rows about the first week in May.

The young plants are not very hardy and will not withstand the frosts that are likely to come as late as the first part of May. The soil should be very warm and moist in order to insure germination. The beans should be at least eight inches apart in the row.

Tomatoes.—Tomatoes must be transplanted. They are very tender and must not be put into the soil until all danger of frost is past, unless they can be protected. The usual time for setting tomato plants in the central part of the United States is about the middle of May. The seed should be sown early in February if early fruit is desired but may be sown in boxes or in the hotbed as late as the first of April. The plants should be transplanted first to small paper pots, two inches in diameter, and when the roots have filled the small pot the plants may be transplanted to four-inch pots. The plants cared for in this way will be ready to bloom by the time they are set in the garden. The lower branches may be pruned off but it does not pay in the small garden to prune the vines very heavily.

Vegetables for the Garden	Varieties Suggested	Amount of Seed (Approximate)
Parsnips	Hollow Crown	One tenth ounce
Chard	Lucullus	One tenth ounce
Lettuce	Black Seeded Simpson	One fifth ounce
Radishes	Icicle and French Breakfast	Two ounces (for several plantings)
Peas	Notts Excelsior	One fourth pint
Beets	Blood Turnip	One fifth ounce
Carrots	Chantenay	One tenth ounce
Head lettuce	Wayahead, May King or Big Boston	Twenty plants
Cabbage	Early Flat Dutch	Twelve plants
Beans	Stringless Green Pot	One pint
Tomatoes	Ponderosa, Earliana, Bonnie Best	Eight plants
Onions	White Bottom	One quart (depends on size)

Draw to scale a plan showing your home garden as it was planted last year. Draw the improved plan. Help your father and mother in carrying out the new plan for the garden this year.

NOTE TO TEACHER.—A contest may be arranged for the growing of home gardens according to the suggested plan and perhaps local patrons will be willing to offer prizes. It is better to have all gardens planted according to one plan, even though some suggested vegetables may be new or unpopular at first. Garden shows should be arranged for the exhibition of the products.

FACTS TO BE STUDIED

Why Have a Garden?—There are many reasons why every farmer should have a garden. More attention should be given to the growing of fresh vegetables for the table. Chief among the reasons are:

1. Vegetables furnish healthful food.
2. Fresher vegetables may be obtained from the home garden than from the grocery store.
3. Vegetables from the garden help to reduce the high cost of living.
4. A larger variety of vegetable food may be secured.
5. A continuous supply of fresh vegetables may be had throughout the season.
6. The garden may be made a source of "extra money" on the farm by specializing on a few vegetables for sale.

The Garden Plan.—The garden should be planned as carefully as any other part of the farm work. A carefully designed plan will:

1. Save labor at planting time.
2. Conserve space.
3. Provide for necessary cropping.
4. Save labor in cultivation.

No exact plan can be given that will meet the needs of all farmers. The plan will depend on the tastes of the family, the size of the garden, and the section of the country. A suggested plan may be found in Circular No. 154 of the Illinois Agricultural Experiment Station and in most books on gardening.

Soil for Gardens.—The soil is a most important factor in growing a garden. Since the value of many of the products depends upon their early maturity, the soil should be of such a nature as to promote early growth. A loose sandy soil dries out early in the spring and warms up early. The garden should have a south exposure and good drainage is a necessary factor in garden soils.

Gardens should be plowed in the fall and covered with a light covering of well-rotted manure as fall plowing conserves moisture and causes the soil to dry out earlier in the spring. The soil should be worked as early in the spring as possible and finely pulverized. If the soil is sour, a dressing of slaked lime should be applied.

The large farm garden should be planted in rows far enough apart to allow cultivation with horse-drawn cultivators, thus saving much time. Frequent tillage conserves moisture and keeps down weeds. The hoe, rake, and hand cultivator should be used to supplement the larger cultivator in working between the vegetables in the rows. A five-fingered weeder is a most convenient tool for hand cultivation in the garden. The soil should be stirred continually during the season. The practice of allowing the weeds to grow up as soon as the crops

begin to mature is a bad one. Continued tillage conserves moisture and keeps the soil in good physical condition and plant food is more available when the soil is in good condition.

Harvesting Garden Crops.—Most vegetables are good for the table during a short period of time only. Peas, radishes, lettuce, sweet corn, beans, and many other vegetables must be harvested just at the time when they reach the stage of maturity when they are good for the table or they become woody or tough and are of little value for table use. It is best to cut all vegetables for the table early in the morning while the stems and foliage are full of water, making them crisp. Vegetables lose much of their freshness when they lie on the counter in the grocery store for any length of time.

All garden vegetables that are to be kept during the winter should be harvested before frost except parsnips, salsify, and horse radish, which may be allowed to freeze.

Storage.—Too little attention has been given to the storage of vegetables for winter use. As many vegetables can be stored, the cost of providing the table with food during the winter can be materially lowered by proper kind of storage. Most vegetables which are cooked in preparing them for the table can be canned. The list includes string beans, beets, peas, corn, rhubarb, greens, pumpkins, sweet potatoes, and tomatoes.

Potatoes may be stored in cellars or in outdoor pits but should be stored where there is some moisture and a low temperature. Parsnips, carrots, and beets may

be stored in cool cellars, but should be covered with sand to prevent withering. Cabbage may be stored in pits or in cool cellars. The outside pit should be well drained and ventilated. The vegetables should be covered with straw or other dry material before they are covered with soil and a trench should be dug around the pit in order to secure good drainage.

Onions should be stored in dry places with plenty of ventilation as they will soon begin to grow if stored in damp cellars. Sweet potatoes require a warm, dry atmosphere, as do squash and pumpkins, and may be stored in the attic near the chimney if the attic is warm. The storage of vegetables should be as much a part of the farmer's program as the planting of the garden.

Problems and Review Exercises

1. List all the vegetable crops grown for food in the community.
2. What vegetables are canned in your home? Which ones are stored in other ways?
3. Tell how an outside pit has been made on your farm. Compare the different methods described in class. Which is best?
4. What difficulties have you had in starting your garden?
5. Give five reasons for planning your garden.
6. What plants must be transplanted from the hotbed?
7. Suggest methods of watering a small garden.
8. Keep a record of current prices as suggested in the home work and determine the total value of products harvested from your garden.
9. Compare the amounts of products harvested from the different gardens and suggest reasons for these differences.
10. What insects have you seen at work in the garden?

XIX

THE FLOWER

Home Work

Observe the visits of insects to the blossoms of fruit trees and to early flowers of other plants. Watch for the first appearance of flowers. What flowers bloom first in the spring in your locality? What different colors have you seen in flowers? Can you suggest a reason why the flowers are highly colored?

Tear a number of flowers apart and study the parts of the flower. Where is the yellow dust called pollen found? How do insects carry this dust from flower to flower?

Tabulate your observations according to the following outline:

Name of Flower	Date of First Appearance	Number of Sepals	Number of Petals	Color	Number of Stamens	Number of Pistils

Tear a tulip apart and draw the different parts in your notebook.

What becomes of the colored petals of the peach blossom after a few days? Does your answer suggest a reason why the petals are colored?

What kinds of insects have you seen visiting flowers?

Facts to be Studied

What Is a Flower?—All boys and girls are fond of beautiful flowers, yet none perhaps has ever asked the question, "What is a flower?" We can describe it, but it is not so easy to tell just what it is. It is a peculiar part of the plant and may be said to be the first stage of the fruit of the plant. By fruit we do not mean apples and such fruits only, but the ripened seed structures of all plants such as corn, wheat, and nuts. The flower is that part of the plant which bears the parts which are concerned in seed production.

Parts of the Flower.—If we examine the flower from the outermost parts to the innermost we find first of all a set of leaves usually green in color. These outermost leaves are called *sepals*. Next there is a crown of more delicate leaf-like structures, usually brilliantly colored, which are called *petals*. Growing just inside the crown of colored petals are a number of slender stem-like structures called

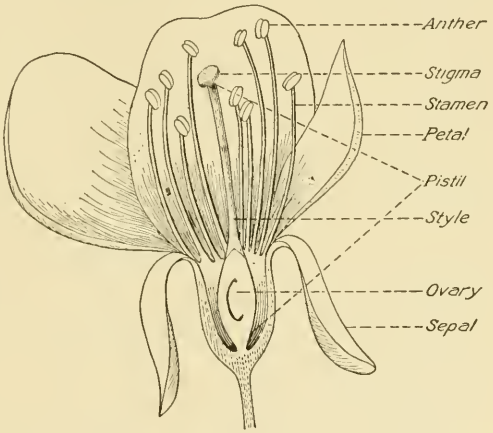


Fig. 34. Flower of cherry, showing parts

stamens, which look like slender stems bearing a seed on the end. This seed-like growth is not a seed but an *anther*, and bears the dust-like pollen which is so familiar to all who have observed flowers. In the middle of the flower grows the *pistil* in the form of a small tube. It is in the base of this pistil, in a pocket called the *ovary*, that the seeds of the plant begin their growth. Before these little seeds develop, the original cells present in the ovary must unite with pollen grains from the stamens. The insects help to carry these pollen grains from one flower to another.

Sometimes a flower has only *stamens* or only *pistils*. If a flower has no stamens, the pollen must be brought from another flower either by the wind or insects before seed can develop. The corn is an example of a plant which has its *pistils* called the "silk" in one place and its *stamens* called the "tassel" in another place. The pollen must fall from the tassel to the silk before the grains of corn can be formed. A grain of corn is the resulting growth when a pollen grain finds its way down a hollow strand of corn-silk and there unites with a cell and begins to grow.

Nectar.—On the end of the pistil is found a sweet sticky fluid called nectar. The honey bee uses this nectar to make honey, and other insects use it for food. The honey bee is also serving the plants in a peculiar way, for when it comes in contact with the pollen, it gathers some on its legs, since the bee's legs are covered with hairs, and as the bee flies from flower to flower,

gathering nectar, the pollen is distributed. Thus one bee may carry the pollen of a single flower to a dozen or more other flowers. If it were not for the insects, many flowers would not receive enough pollen to enable them to produce seeds. The red clover, for instance, must be pollinated by a bumblebee or it will not produce seed. The pollen of the clover is enclosed in a bag-shaped flower and is not distributed except by the aid of the bumblebee as he seeks his nectar. Other insects seem to be unable to enter the clover flowers.

Why Fruit and Seed Do Not Always Develop.—Sometimes cold heavy rains come just when the pollen is ready to be distributed. The rains beat the pollen off and reduce the amount of fruit. Other factors such as frost may injure the pollen and decrease the amount of fruit. Sometimes the freeze comes just after the fruit begins to form and causes the young fruit to drop off. This is often the case with pears.

The flower begins to form within the bud almost a year before the blossom appears. In the apple, for instance, the buds in July will be found to contain young flowers which will burst forth the next spring. Since the flowers must withstand all the weather conditions of the winter months, it is little wonder that many of them are killed by the freezing weather.

Problems and Review Exercises

1. Name the first ten flowers which bloom in the spring in your section.

2. What fruit trees bloom first in the spring? Will fruit trees which bloom necessarily bear fruit? Give reasons for your answer.

3. How much clover seed was produced in your community last year? What is the value of the seed at current prices? The answer is the economic value of the bumblebee to the farmers in the community. Where have you found bumblebees' nests?

4. What insects other than the bumblebee have you seen visiting the blossoms of fruit trees?

5. Write a composition on one of the following subjects:

The Bumblebee and Clover Blossoms
How the Flower Produces Seed
The Most Beautiful Flower in My Garden

XX

TREES

Home Work

Two exercises should be carried out at home in connection with this study. The first one we shall call an "Observation Exercise"; the second one, "Planting a Tree."

Observe the trees on your way to school and make a list of all those which you can name. Gather leaves from those you cannot name and take them to school to get help from some other member of the class or from the teacher. Keep an eye open for the birds, taking particular notice of the trees or shrubs which seem to be favorites with the birds. Decide upon some one distinguishing mark which will help you to recognize each kind of tree. Count the rings on a stump where a tree has been recently cut down. Each ring represents a year's growth. What was the age of the tree? Watch for the first coloring of leaves in the fall. How many colors can you find on a single tree? Find answers to the following questions:

1. How many different kinds of trees can you find on your way to school, including those on your home grounds?

2. What is the distinguishing mark by which you can recognize the following trees:—oak, maple, elm, ash, catalpa, mulberry, wild cherry, sycamore, willow, tulip tree?

3. From what trees or shrubs can you make whistles? At what time of year can you make them most easily? Can you suggest a reason for this?

4. Where are the taller trees found, in the woods or in the open pasture? Can you tell why this is true?

5. What will happen to the young tree after replanting if the branches are not pruned?

6. How much time is required to take up a young tree in the woods and reset it in the home yard? Can you suggest reasons why boys and girls do not seek to improve the home surroundings more often than they do?

7. What is your favorite poem about trees? A poem should be memorized.

8. What is meant by *A tree remains dormant through the winter?*

Planting a Tree.—There is usually a spot in the farmyard that would be more beautiful and might be more valuable if a tree were planted there. Our purpose in planting a tree or a number of trees is to obtain shade or fruit, or perhaps both. If a fruit tree is desired, the teacher should aid the pupils in obtaining good specimens from a reliable nursery or perhaps some farmer in the community will be willing to furnish some young fruit trees for this purpose. Select trees of a desirable variety. If an elm or maple or other shade tree is desired, it may usually be obtained from the woods. Go into the woods and select a good specimen which is not larger than you can easily carry, and with a sharp spade dig around the tree, keeping at

Courtesy of American Forestry.

FIG. 35. A SPLENDID MONUMENT

least two feet away from its base. Take up as many roots as possible and be careful to keep the roots moist as they will soon die if allowed to become dry. Select a spot where shade is needed. The tree should be placed far enough away from the house or barn so that it will not have to be cut away when it matures. Prune the roots so that there are no ragged ends left. This will cause the roots to fit down more closely when the tree is set in the hole and may prevent decay. Dig a hole large enough to set the entire root system without crowding the roots, and make sure that there is plenty of good fine soil with which to pack the roots firmly. Now set the tree in place and pack fine soil about the roots. The tree should be set a little deeper than it was in the woods.

After the tree is set, prune the top severely, leaving only the main branches. If this is not done, the tree will not be able to draw enough moisture through its limited root system and will die.

Facts to be Studied

Value of Trees.—Every boy and girl knows the value of a good shade tree, for it not only provides a resting place for man and beast away from the hot summer sun, but it greatly enhances the beauty of the home surroundings. Fruit trees furnish both shade and fruit, and can be easily grown, yet many farmers buy fruit each year to can or for other use. In most

instances a plentiful supply of good fruit could be had by planting a few trees about the premises.

The forest furnishes the material for our houses, our wagons, our furniture, and for many other necessities which could not be made from other material. Boys and girls should help to increase the number of trees in the community. No greater monument can be built. Wouldn't you like to have some one say a quarter of a century hence that you had planted the beautiful shade tree on the school grounds or in the home yard?

When to Plant.—Trees may be planted in the spring or in the fall; but, if planted in the spring, they should be set early before the hot weather begins. An advantage of fall setting is that the trees become set in the soil and are ready to start new growth early in the spring. Usually an arbor day is designated by state officials and the school should give this day to tree planting. The day's program in school may be upon the subject of "Trees and Their Value," and the pupils may take a part of the day to plant some trees on the school ground as suggested in the chapter on "Beautifying the School Yard."

Water Required.—Trees like other plants require much water, an apple tree of medium size drinking as much as a barrel of water per day. The tree takes up a part of its food in solution from the soil. The growing tree seems to balance its growth so that the root system will take in enough water to supply the branches with moisture in order to keep them from

wilting. Water is constantly being evaporated from the leaves so that there is a constant movement of water through all parts of the tree. This is the reason it was suggested that you should prune the branches of the tree which was newly set. Many of the roots were necessarily lost when the tree was taken up and if the tree were reset with all its branches remaining as they were, the root system could not drink in enough water to supply the branches and keep them from wilting.

Trees for Fence Posts.—Although the iron fence post and the concrete post have come into common usage, there will always be need for wood posts. Some farmers plant rows of trees such as the catalpa or osage orange, commonly known as "hedge," along fence rows, expecting to use them later as posts. Others plant forest plantations with these trees and allow them to grow into post material. The cedar and white oak of the forest make excellent fence posts. It will be interesting to observe the kind of wood used for posts in your community. Try to determine the relative lasting qualities of the different kinds of fence posts by asking farmers who have used different kinds. Every farm should have a place for a small plantation of trees.

Adaptation to Climate and Soil.—Trees like other plants adapt themselves to surrounding conditions, each section of the country having typical trees. Some trees require much water and thus are found growing in humid areas while others are able to grow with very

little water and may be found in the dry areas. Differences in the root systems and leafing habits make it possible for trees to grow in different climates. Those with branching root systems and broad thin leaves require more humid climates than those which have a long tap root and spiny leaves. The oak trees, for instance, are found growing in humid climates, while the evergreens are found in cold dry climates. The latter are so called because they remain green throughout the winter. The oak tree, on the other hand, sheds its leaves each autumn. It is interesting to note that the leaves of the white oak, though they turn brown in color, remain on the trees most of the winter. A study of your local community should tell you what trees are typical in your climate.

Review Questions

1. List as many products of trees in your community as you can.
2. Give complete directions for planting a young tree.
3. Why should the top be pruned when a tree is set?
4. Name the trees most commonly found in your community.
5. What trees are used most extensively for lumber?
6. How can you tell the age of a tree?
7. Give the advantages of planting trees in the fall.
8. What kinds of trees are used for fence posts in your locality?
9. What is meant by a "humid climate"?
10. Survey your home lot and determine the location and the kinds of trees you will set out.
11. Decide if necessary on a spot to plant a tree or trees on the school lot.

XXI

LEGUMES

Home Work

The home work in this project should acquaint you with the different kinds of legumes growing in your locality. A survey of the farms represented by the class should be made, in order to find out the number of kinds of legumes grown on these farms. Individual plants of the legumes found in the community should be brought to school, pressed, and mounted on cardboard for study. If an old alfalfa field is available, take up some of the plants. Be careful to preserve the tap root which is the long central root. This will require much digging, but it will be worth while as it illustrates the root system and the ability of the plant to reach far down into the soil for moisture. How long are the roots you have dug out of the soil? Tear a clover head apart and count the single flowers in the head. How many do you find? Do you find any tiny insects in the flowers? Observe the bumblebee as he goes from clover blossom to clover blossom in search of nectar. How many clover heads do you think a bumblebee will visit in a minute? Have you seen other kinds of insects sucking nectar from the clover heads?

Tabulate the observations of the class as follows:

Kind of Legume Observed	Color of Flower	Kind of Root System	Height of Plant	Acres in Community

Facts to be Studied

Value of Clover.—One frequently hears the statement that "clover is a good manure" which means that it is a good fertilizer for the soil. The importance of clover as an essential to good crops in the system of grain farming is being appreciated as it never has been before. Farmers realize that yields of good grain crops cannot be maintained without the use of clover or some other crop which is very closely related to clover.

Clover Gathers Nitrogen.—Years ago men recognized the value of clover as a fertilizer, but they did not know just why it made the soil richer. We know now that it is because the clover has the power to transfer nitrogen from the air to the soil. It is on this food that the plants thrive. On the roots of the clover are found little pea-like structures called nodules, which are full of little bacteria. The bacteria take the nitrogen from the air and work it over into nitrogen compounds which the plant takes up as food. Nitrogen is one of the most important food elements which the plant needs and when it is found in large quantities in the soil

a bumper crop is produced. If there is little nitrogen in the soil, corn will have a sickly yellow color; while if there is much nitrogen present, the leaves will have a deep green color.

Courtesy Illinois Agricultural Experiment Station.

FIG. 36. NOTE THE LITTLE BALLS OR NODULES ON THE ROOTS. THESE NODULES ARE FILLED WITH MICROSCOPIC BACTERIA WHICH AID THE PLANT IN GETTING FOOD FROM THE SOIL.

What Is a Legume?—Nitrogen may be applied to the soil in the form of a commercial fertilizer, but this method is too expensive except on small farms where intensive farming is carried on. The air is made up of approximately four parts nitrogen and one part oxygen. Since there is such an abundance available, there is no need for any farmer to allow his crop to suffer for want of this important food element. Clover and plants closely related to clover take nitrogen from the air and when the plants are turned under, this nitrogen becomes available to other crops. The plants which have the power of taking nitrogen from the air are called legumes, from a Latin word, "legumen," which means to gather. There are many kinds of legumes, but only a few are commonly

known. The most important of the legumes are clover, alfalfa, cow peas, soy-beans, garden peas, and beans.

Flowers of the Legume.—The legume family is very peculiar in many respects. We may see some of these peculiarities by examining closely the flower of the sweet pea or clover. The flower is called a closed flower; that is, the stamens and the pistil which are concerned in the production of the seed are all enclosed in a pocket-like structure which, in some instances such as in red clover, makes it impossible for the plant to produce seed without the aid of insects. The insects in flying from flower to flower distribute the pollen which they gather on their legs incidentally while searching for nectar in the flower. They carry this pollen to other flowers and help distribute it where it is needed to start seed growth.

Legumes Like Sweet Soil.—Another peculiarity of the family is that the members do not care for an acid or sour soil. They must have a sweet soil in order to thrive properly. Much land which has been cropped for a long period of time has developed a sourness or acidity which checks the growth of clover and other legumes. Experience has proved that the application of lime to the soil will eliminate this sourness. The application of lime has increased the yield of clover from practically none to over three tons per acre. In many parts of the country, clover cannot be grown at all without the application of lime. In another chapter the use of limestone is discussed.

Legumes as Feed.—Farm boys know that clover hay, alfalfa, or cow-pea hay is a good feed for milk cows. These crops contain large amounts of nitrogen. Milk also contains much nitrogen. The cow can produce milk much more economically from the legumes than from such roughage as timothy, straw, and corn fodder because these hays do not contain much nitrogen. Legumes are excellent feed for growing live stock. Pigs thrive in clover pastures, and chickens lay well when they can get green clover or alfalfa to eat.

Growing Clovers.—Red clover is one of the most common legumes grown in the United States. Its wide use as a hay and its use as a fertilizer makes it a very important economic crop. Alfalfa is another very valuable legume. Its culture will be discussed in a separate section. Clover is usually sown in the early spring, sometimes being sown in the wheat and sometimes in the oats. Frequently if the season is not ideal for clover, the other crops grow so abundantly that the clover is smothered out. When clover is used in a rotation it is usually allowed to "stand over" one year after the year it is planted. At least one crop in four years should be turned under to help enrich the soil.

Clover seed and seed of other legumes sell for high prices. We must think of the legumes as a family of plants differing from other plants in habit of growth, in earmarks of the plants, and in cultural methods required for their growth.

Problems and Review Exercises

1. How does a legume differ from other plants?
2. In what way is clover used as a fertilizer?
3. On what kind of soil will clover fail to grow?
4. What is nitrogen?
5. How do the flowers of the legume differ from other flowers?
6. What is the feeding value of legumes?
7. Name the common legumes.
8. How is clover usually sown?
9. How many acres of alfalfa were grown in your community last year? of clover? of other legumes?
10. Tell of the experience of your father or a neighbor in growing legumes.
11. At what time in the year is clover turned under in your locality? Can you suggest a reason for turning it under at this time?
12. Does corn grow better after a crop of clover has been turned under the soil? Does clover help the cotton crop in the same way?

XXII

ALFALFA

Home Work

How many cuttings of alfalfa may be made in your community? Give the dates of these cuttings. What yields are obtained? Compare the total yields of alfalfa per acre with the yield of other hays grown in your community. Study the method of harvesting the crop and compare it with the methods used in harvesting other crops, keeping in mind the labor required, time of year, curing, storing, and danger of loss. Can alfalfa be baled from the shock in your community or must it be stacked or put in the shed for some time before it is baled?

Feed alfalfa together with other hays to cattle and horses. Which hay is relished most? Feed the dry hay to hogs and note the result. Feed other hays to the hogs. Will they eat timothy and clover?

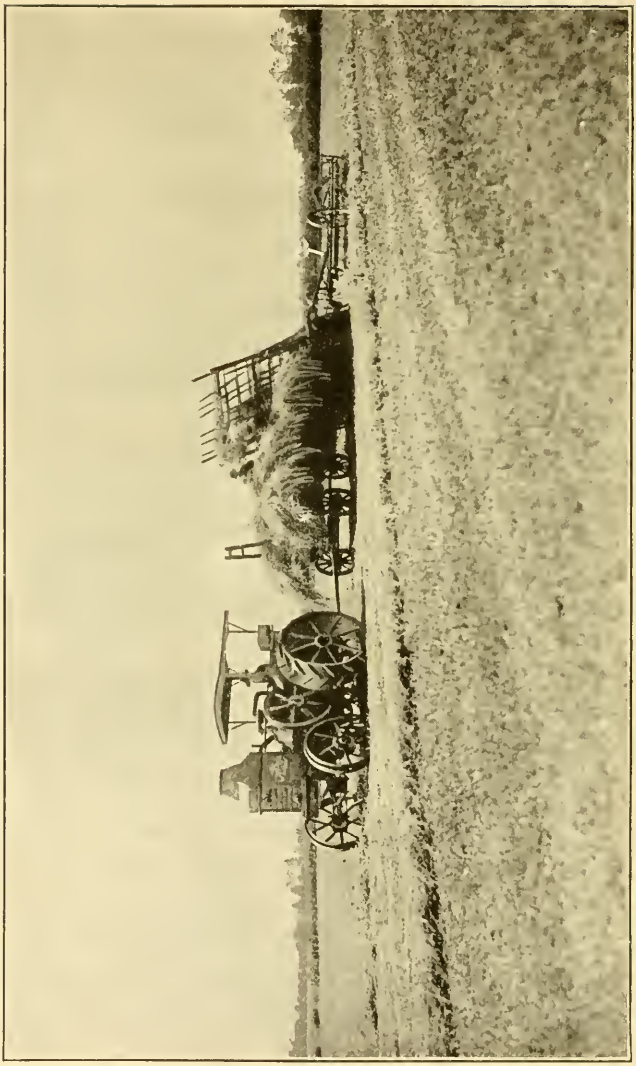
Compare the market quotations on alfalfa with other hays. Such quotations may be found in any city papers. What is the local price per ton paid by buyers? What margin does the city quotation allow the buyer? What items of expense must be paid from this margin by the man who buys from the farmer and ships to the market?

Facts to be Studied

History of Alfalfa.—Alfalfa has been grown for thousands of years, records of its growth showing that it was grown many hundreds of years before the birth of Christ. It has been grown in America more than a century but has not obtained the foothold which it deserves in this country. Nevertheless, the crop is rapidly assuming much larger proportions as compared with other crops. Farmers are beginning to appreciate its importance as a legume and particularly as a feed for young live stock and milk cows.

At present most of the alfalfa grown in the United States is produced in the western states, for it is well adapted to the climate of this region. Its root system gives it a place also among the crops of the dry climates, as the long tap root can go to great depths for water. The rich soil of the corn-belt area is adapted to the growth of heavy crops of alfalfa, but the wet seasons which frequently come at harvest time, especially in the early summer, have limited the production to small areas. Farmers do not grow alfalfa on a large scale because of the difficulty of curing the hay during the wet seasons. As farmers become better equipped for the care of the crop, they will grow larger areas on the corn-belt farms. Alfalfa is being grown in many sections as a legume in rotation, often taking the place of clover.

Adds Food to the Soil.—Alfalfa is one of the most effective food gatherers among the legumes. It is able



Courtesy Advance Rumely Co.

FIG. 37. MODERN METHODS OF HAY MAKING

to take some of the nitrogen gas from the air and turn it into food for the growth of the plant. The roots have large numbers of the pealike structures called nodules, which means that the plant is well supplied with the little bacteria which gather nitrogen from the air. When the crop is plowed under, this nitrogen is added to the soil. The luxuriant growth of roots, stem, and leaves adds much humus or organic matter to the soil when plowed under. The crop is an excellent one to grow in rotation where corn is grown.

No hay crop or forage crop will produce better results when fed to growing live stock or to dairy cows for milk production than alfalfa. The necessary protein or muscle building material can be supplied much more cheaply in alfalfa than in bran or other more concentrated feeds. Alfalfa is relished by live stock, especially cattle. Farmers feed alfalfa to horses with good results.

The root system consists of a long tap root which reaches many feet into the soil, and a few smaller roots near the surface. It is stated that these tap roots have been found to reach fifty feet below the surface, along embankments. At any rate, it is safe to say that these roots penetrate to great depths in order to get water for the growth of the plant. The roots also gather mineral substances and bring them to the upper parts of the plant, thus enriching the surface soil. Alfalfa requires about one thousand times its own weight of water to complete the season's growth; that is, a thousand tons of water pass through the plants which make up a

ton of dry hay when harvested. However, an overflow will drown the crop very quickly, which means that the soil in humid climates must be well drained before it will grow alfalfa.

A sandy loam is perhaps the best type of soil for growing alfalfa in most regions. A loose soil of this type allows the roots to penetrate to great depths and such a soil is usually well drained. The plant will not grow well in sour soil for the bacteria on the alfalfa roots do not thrive in sour soils and the plant is thus unable to take in nitrogen from the air. Soil which is sour may be made good for growing alfalfa and clover by the addition of limestone, the use of which is discussed elsewhere. Farmers should not waste time and seed trying to grow alfalfa on soil that is sour until plenty of limestone has been added.

The microscopic bacteria which grow on the roots of alfalfa are very particular about their hosts or the plants upon which they grow. They grow upon the roots of alfalfa and sweet clover and are not likely to be found in new fields. Inasmuch as they are necessary to the best growth of alfalfa, farmers should make sure that the soil contains plenty of bacteria. There are several ways of introducing them into new fields, a common method being to secure a wagon load of soil from an old field of alfalfa or sweet clover and spread it over the new alfalfa field. It may seem as though a wagon load of ordinary soil would do very little good when spread over a field, but the bacteria

grow very rapidly and spread widely when they are once started.

Alfalfa is a very particular plant requiring an extra good seed bed. Weeds will crowd out the young plants if they are allowed to grow. The seed must not be sowed on thawing ground as clover seed is sowed in early spring, but should be sowed later in the spring or early in the fall. In the corn belt, both times are considered good seeding dates, but more farmers seed in the fall. Whether the seed is sowed in the fall or spring, the soil should be cultivated for several weeks before seeding time to kill the weeds, to pulverize the soil, and to save moisture; this usually insures an ideal seed bed. Sometimes alfalfa is sowed with oats or some other "nurse crop," but there is danger of the young plants being smothered out by the more rapidly growing oats.

Alfalfa should be harvested when the young shoots which are to make the next crop are about two inches high. These shoots grow out from the crown of the plant and can be easily seen. In most climates the plants are just beginning to bloom at the time the next growth starts. If the alfalfa is cut before the next growth starts, some time will be lost; that is, a full growth is not secured, and if the cutting is delayed until the next shoots are higher than two inches, the sickle will clip the tops of the shoots and check their growth.

The hay should be raked with a side delivery rake within a few hours after it is cut. If allowed to remain in the swath longer than four hours on a good "curing"

day, the leaves will become quite dry and will shatter off when the hay is raked. Much of the food value of the plant is contained in the leaves. The hay should be put into tall shocks made as small as possible in order to allow it to cure. It will cure best if allowed to remain in the shock for several days. Hay caps, which are canvas coverings for the shock of hay, are very useful in humid climates where rain is likely to interfere with the harvest.

Problems and Review Exercises

1. On the community map, shade in green the portions which were planted in alfalfa during the present season. Make a survey of the land thus devoted to alfalfa to see whether the proper soil was used. Study the soil from the different plots devoted to alfalfa. Make recommendations for next year's crops.

2. Determine the value of the crop in the community, estimating the yield per acre as the same as was grown on your father's farm or on some other farm where the yield is known.

3. If your father is growing alfalfa, talk to him about the value of the crop and write a report of your talk with him. If he does not grow alfalfa, tell him what you have learned about the plant from the other members of the class.

4. How many tons of alfalfa would be required to feed the cows on your father's farm during the winter months?

5. Test for acidity the soil on your farm, and in an alfalfa field. Take a small ball of soil from a depth of eight inches; wet it, and place a piece of blue litmus paper in it. If the paper turns pink, the soil is sour and needs some lime. The litmus paper can be secured from a drug store.

6. Enumerate the things you have learned in this study which will help you in growing your alfalfa crop.

XXIII

GROWING COTTON

Home Work

Select seed from the field before the main crop is harvested. Study individual plants and note differences.

If possible visit a field of cotton during picking time. How is the cotton handled in the field? What does it cost to get the cotton picked? Can you suggest any way of increasing the efficiency of the plan now being used?

Go to a field that has been planted in cotton year after year without any crop rotation, and compare the crop with the crop on a field where crop rotation has been carefully practiced.

What insects can you find in the cotton field that do damage to the crop? Each pupil should visit a gin and observe the methods of caring for the cotton. How is cotton baled? What is the average weight of each of the bales of cotton? How are the bales handled? Find out the relative value of the seed and the fibre of cotton. Describe the method of preparing the soil for the cotton crop which is used in your community. Is any system of crop rotation used? If so, what crop is planted instead of cotton?

Facts to be Studied

Importance.—Cotton is one of the most important products of the farms of the United States. It requires a warm climate, so is found in the southern part of the United States. More cotton is grown in Texas than in any other state. Cotton is manufactured into clothing and other commodities. Cotton manufacture is perhaps the most important single industry related to the farm.

The Plant.—Inasmuch as cotton growing is confined to the southern states it will be of interest to northern pupils to know something about the plant which produces the material for so much of our clothing. The plant is related to the common hollyhock which is widely grown for its beautiful flowers. The leaves and flowers on the two plants are similar. The plants are rather woody and much branched.

Fibre and Seed.—The fibre of cotton constitutes about one tenth of the weight of the plant while about one fifth of the weight is seed. The fibre is spun and woven into cloth and the seeds are used in the manufacture of various by-products, such as feeds, oil, and fertilizer. Cottonseed meal is a ground feed used as a feed for cattle and some other animals. The meal is very rich in protein which makes it valuable as a part of the milk cow's daily ration.

Growing Cotton.—Cotton is planted in the spring after the danger from frost is past. It is planted in

rows much the same as corn, but it is necessary to plant an abundance of seed and thin the plants later because so many seeds do not germinate. The seed bed should be particularly well prepared in order to give the young plants a start. The plants are delicate and require frequent cultivation at first. The soil should be kept loose and free from weeds.

Marketing.—The marketing of cotton is an expensive process. The locks of lint and seed are picked from the bolls by hand. One individual may pick as much as 500 pounds in a day though that amount is unusual and 200 pounds is a good day's work. Machine picking is not satisfactory because so much trash is picked with the cotton. From the field the cotton is hauled to the elevator where the seed is removed by the machine called a cotton gin. After the seed has been removed, the lint is baled for shipment to factories. The bales weigh about 500 pounds each.

Summary.—There is little doubt that cotton will hold its high rank among farm crops in the United States because of the increased demand for the manufactured products made from cotton. One of the most important movements in the south has been the changing from a one-crop system to a system of crop rotation, including the growth of legumes one year in the rotation. This system helps to keep up the fertility of the soil and to keep down the damage by insects.

Problems and Review Exercises

1. What different kinds of cotton are produced in your community?
2. How is the seed separated from the lint?
3. Tell how cotton is planted.
4. What are the advantages of rotating crops?
5. Describe the cotton plant.
6. Can you find the date when the cotton gin was invented? Who invented it?
7. Find out what insects damage cotton in your community.
8. What becomes of the stalks after the cotton is picked?

SECOND YEAR

I

BETTER EGG PRODUCTION

Home Work

Culling the Flock.—One of the most important factors in egg production is the selection of layers. Hens that do not lay for long periods of time are not profitable. Each pupil should secure the coöperation of some one at home and cull the home flock in order to weed out the non-producers. Culling not only insures more egg production from your flock, but it is necessary to cull if one wishes to "breed up" a flock to higher production.

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Fig. 38.—"Lady Eglantine," a white leghorn hen which laid 314 eggs in 365 days

When to Cull.—The culling should be done as early in the fall as possible. August and September are the best months. This exercise should be one of the first ones undertaken by the class in the fall. Of course

whenever undesirable hens are found in the flock they should be culled out. Why cull in these months? When do the hens begin to molt? When are most of the eggs produced?

Culling.—The flock should be "shut in" at night in rather close quarters so the hens can be easily caught. There should be two persons working together in culling the flock. One should catch the hens and hand them to the person who is doing the culling. The hens which are to be disposed of should be put into a coop at once. The best ones which are to be used in the breeding pen should be marked with leg bands. Cull in the daytime when there is good light in order to determine the color of beak, shank, and skin about the vent.

Hens to Be Removed.—The sick hen should be removed first of all for she does not lay and she spreads disease. Sickness is indicated by a drooping attitude, bluish-colored comb, poor appetite, dull eyes, and general dullness. Sick hens should be killed unless the trouble seems to be temporary, in which case they should be separated from the flock and given special attention.

All hens that are well along in the molt before September are likely to lay for short periods and should be removed from the flock. Retain the ones which do not begin to molt until late in the fall, for they will lay longer in the season and molt much more quickly.

Hens which have deep yellow shanks and beaks at this time of year are not laying. This, of course, will not be an indication in the case of birds which have light-colored shanks naturally.

The comb is another indication of a laying hen. When a hen is laying, the comb will be large, waxy, and red in color, and when laying ceases, the comb becomes shrunken, pale, and scaly. It is our purpose to cull out the non-layers at this season, so the comb will be an easy guide, but the other points should also be considered.

When the hen is in a laying condition, the body fat is reduced. The pelvic bones, the ones which can be felt on either side of the vent, become thin and flexible in the laying season. They are far enough apart in most laying hens to admit the spread of from three to five fingers of a person's hand. If not more than two fingers can be placed between these bones, the hen is probably not laying. Laying hens are of course eating large quantities of food and consequently the abdomen is larger, looser, and more flabby than in the case of the non-laying hen. Hens with a smooth, contracted, neat appearance at this time are usually not laying and should be culled out. The skin covering the abdomen is soft, moist, and pliable in laying hens. It loses its yellow color when the hen is laying, due to the loss of body fat at this time. Hens with tight, dry, hard, fatty vents should be discarded as non-layers.

It will be unprofitable to keep hens that have stopped laying as early as August or September, so they should be sold from the farm. An exception should be made in the case of hens that have raised a flock and that have not yet begun to lay after their vacation. The general indications of laying ability in such hens should be used as an index to tell whether or not they should be sold from the flock. Old hens that seem to have outlived their usefulness should be sold from the flock.

It is difficult, if not impossible, at this time to discover the pullets which will prove to be poor layers. However, if some of the pullets are to be sold they should be picked carefully. Save the most thrifty ones which show early maturity, good color, and well-developed bodies. Pullets with long, snakelike heads are not desirable.

The Breeding Pen.—Later in the fall the hens which lay longest and molt late should be separated and placed in a pen by themselves. The eggs from this pen should be used for hatching. The pullets of next year's flock are more apt to have good laying qualities if hatched from eggs produced by the long period layers. The pullets should be used the first year as layers and hatching eggs should be taken only from the hens which have shown their ability to produce. Most farmers do not take the time to make up the breeding pen as a separate part of the flock, but it will pay big returns to do so. Boys and girls can render a good service by helping their parents choose the hens for this pen.

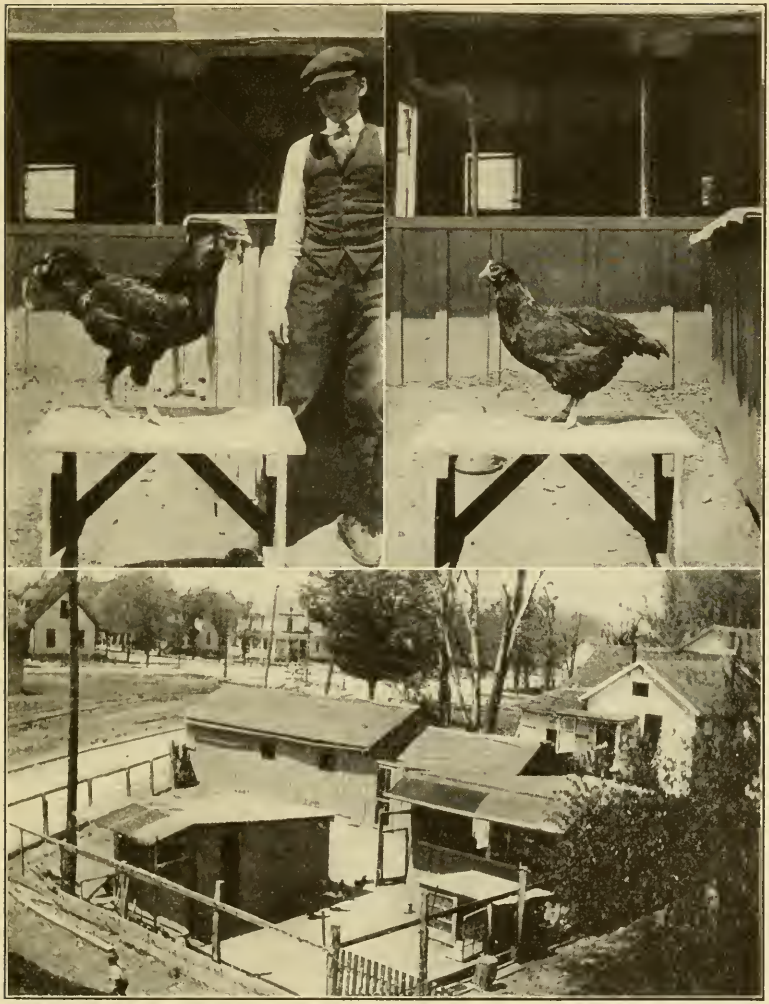

FIG. 39.—THIS BOY, FIFTEEN YEARS OLD, SOLD MORE THAN $400 WORTH OF EGGS AND CHICKENS FROM HIS BACK-YARD PLANT IN ONE YEAR.

Facts to be Studied

The Farm Flock.—The production of food by maintaining farm flocks of poultry has been increasing very rapidly. The possibilities, however, of such production have not been realized or even approached. Almost a billion dollars worth of products come from the poultry yards of the United States each year. Boys and girls can do much to lower the cost of living by helping to make the poultry yard more productive.

Choosing a Breed.—There are many reasons why every farm should produce chickens of a single breed, but, as a matter of fact, most of the flocks found on the farms are not of a pure breed. The mongrel flock has been the cause of much failure in the poultry yards. There are many breeds of poultry and more than a hundred varieties so that any farmer may have his choice of breeds and varieties. The preference of the farmer and of his wife should be one of the important factors in choosing a breed. The poultry will get better care if it is the choice of the person caring for it. The American breeds are very popular for farm flocks in the United States. They are good egg producers and at the same time produce a good quality and quantity of food in the form of meat.

Breeding Up.—If one has a mongrel flock of chickens, there is a possibility of producing a better flock and of grading up the flock to a state which is practically "full-blooded" or pure-bred. To grade up a flock, the

best layers should be selected each year for the breeding pen and males from high-producing flocks should be used. Many farmers believe that all that is necessary to improve the flock is to introduce "new blood" from year to year. New blood alone will not improve the flock. The new blood should be obtained from a good strain of poultry or, in other words, from a high-producing flock.

Selection of Birds.—Directions have been given for the culling of a flock for the purpose of selecting the layers. Care should be taken to keep up the vigor of the flock by discarding the weaker birds whenever found. The flock should be selected with a view to egg production, which depends upon the ability of the hens to eat food and to turn this food into eggs. Therefore, the hens should be selected with regard to their ability to eat and digest large quantities of food.

Feeding the Flock.—Pupils should read the chapter on *Feeding Animals* to learn the food nutrients and the purposes for which they are fed. The essentials of poultry feeding may be stated as follows:

1. Allow the flock plenty of fresh, clean water at all times. It is surprising to note the amount of water which chickens will drink in warm weather. In cold weather the water should be warmed. It may be kept warm by keeping it in double-walled fountains which may be purchased on the market.

2. Hens require grit for the purpose of grinding the food when it is taken into the gizzard, and oyster shell or limestone is necessary for the production of eggshell. The oyster shell, however, does not take the place of the grit which is necessary for grinding food.

3. Green food of some kind is necessary for the best production of eggs. Sprouted oats are good for winter food. The oats should be soaked for twenty-four hours, then placed in a pan in a layer about three inches deep. Keep in a moderately warm place, sprinkling with water from day to day as needed. The oats should be ready to feed in a week's time. Chopped alfalfa or clover is excellent green food for the flock and is more palatable when steamed or wet with hot water.

4. Meat scraps or skim milk make good animal foods for egg production. Some kind of animal food is necessary for egg production.

5. A mixture of corn, oats, and wheat makes a very desirable grain mixture for laying hens. The grain should be fed whole.

6. Mashes are usually made by mixing bran, shorts, meat scraps, and other ground feeds. The mash may be fed dry in self-feeders, but is sometimes fed wet. There is more danger of contamination, however, if the mash is fed wet.

7. A scratching place should be provided for the hens by keeping straw or other litter in a part of the house. The grain may be fed in this scratching place.

Housing.—Plenty of sunshine and exercise are essential to the best results in the poultry yard. The runway should be dry and protected from the cold weather. Winter eggs cannot be secured when hens must remain out in the cold most of the time. They should be provided with ample housing room and should be kept warm. Hens should begin laying early in the winter, if they are properly fed and housed. A house twenty feet square is large enough for fifty to seventy-five hens of the American breeds. The walls should be very carefully covered with building paper

if there are cracks or knot holes, as draughts cause colds. Plenty of fresh air should be provided at all times. The south side of the house may have windows covered with cheese cloth during the winter, and at no time should the house be entirely closed.

Eggs for Hatching.—The incubator is a common device on the farm now, its use having become almost universal in the United States. Eggs for the incubator should be carefully selected, those which are uniform in size and color, and which have good shape being best for hatching. Eggs for hatching should not be washed, as washing removes a fine outer coating which protects the pores in the shell. Use only clean fresh eggs. They should be gathered several times a day in cold weather to prevent chilling. If the eggs are to be kept for some time before they are given to the hen or placed in the incubator, they should be turned frequently. Make sure that eggs for hatching are taken from the best layers on the farm. This can be done only when the best layers are separated and placed in a pen away from the remainder of the flock. It is important to hatch chickens as early as possible in order to have early-matured pullets for winter laying. The cockerels bring the highest prices when they can be put on the early spring market as "frys" or "broilers."

Care of Young Chicks.—A very important part of egg production on the farm is the proper care and feeding of the young chicks, as they are to grow into

the layers for the next year. All weaklings or cripples should be killed, for they will never develop into healthy, robust chickens and in many cases they spread disease among the remainder of the chicks. Much depends upon the first few days of a chick's life. No food should be given for the first thirty-six hours, as there is sufficient nourishment in the body of the newly hatched chick to nourish it for that length of time. If more food is eaten, the digestive tract is overladen and digestive disorders soon arise. If the chicks are hatched early, they should be kept in a well-ventilated brooder as long as necessary to protect them from the cold. Many farms are equipped with brooder houses containing brooder stoves.

Little chicks should be fed a mash and grain which is rich in mineral matter and protein. No one ration is best for producing growth in young chicks. The grain usually consists of wheat and cracked corn. The mash should contain wheat bran, corn meal, beef scraps and bone meal, a large proportion of corn meal being desirable. No feed that is not clean and wholesome should be allowed in the feed troughs for young chicks, as much disease results from unsanitary methods in feeding. Skim milk is an excellent supplement to grain rations for chicks, but should be fed in amounts which the chicks will drink and should not be allowed to remain in the pans to become sour and contaminated.

Pullets for Laying.—The pullets and cockerels should be separated wherever it is practicable to do so, as the

cockerels get most of the feed when they are fed together. On most farms, however, this is not practicable and in such cases the grain should be scattered over an area large enough to insure the pullets a good meal. It is important to give the pullets all the opportunity for growth possible as they are to be the winter layers. A wide range is essential to the development of good pullets.

To Produce Infertile Eggs.—The larger percentage of spoiled eggs which have spoiled somewhere along the line between the nest and the consumer are spoiled because they are fertile and thus contain a live, growing germ cell which will grow into a chick if given the proper temperature and time. Eggs which are infertile do not spoil so quickly. Infertile eggs may be produced through the summer by selling, killing, or confining the males as soon as the hatching season is over. Roosters in no way increase the egg supply and are useless in the flock after the hatching season has closed.

Lice and Mites.—Chicken lice and mites cause the hens to stop laying. They sometimes weaken little chicks so much that they die. All roosts and houses should be whitewashed and sprayed with disinfectants. Sanitation is the best preventive, but if lice are found on the chickens, use blue ointment or lice powder until all lice are exterminated.

Disease.—Badly diseased chickens should always be killed and burned to prevent further spread of the disease. Light colds and similar disorders can be cured.

Fresh air and sanitation are good preventives. The houses should be cleaned frequently and the yard must be kept clean. It is well to have greens growing in parts of the yard. Remove all rubbish and filth which might harbor germs.

Write to your experiment station and ask for circulars on diseases of poultry.

Problems and Review Exercises

1. What is meant by culling the flock?
2. Let a member of the class bring a hen to school to illustrate the qualities or earmarks of a laying hen. Another member may bring a hen which illustrates the opposite type.
3. How much time is required for culling a flock of fifty hens?
4. How many hens in your flock lay during the winter?
5. When do pullets begin to lay in your locality? What would cause them to lay earlier in the fall?
6. Why should hens lose the yellow coloring from the beaks and shanks when they are laying?
7. Name rations that are fed for egg production on the farms of the class.
8. What breeds are kept on these farms?
9. What is the average size of the farm flocks in the county?
10. What provisions are you making for culling the home flock? Is it economical to cull the flock?

II

BREEDS OF POULTRY

Home Work

The purpose of this home work is to show you how you may become acquainted with the different breeds of poultry to be found in the school community. A survey of several farms should be made by members of the class to determine the number of fowls belonging to each breed represented, and the number of cross-bred or mixed fowls in the district. Perhaps you can plan your survey in such a way that the entire district may be canvassed by the various members of the class. At the end of the week the results may be tabulated on an outline similar to the following:

Breeds	Number of Fowls	Number of Farms	Average Number per Farm

Make a careful comparison of the breeds observed, noting the differences among the breeds and the peculiarities or particular markings of each breed. A suggested form for tabulating the results is as follows:

Breed	Variety	Color	Size	Color of Egg	Color of Shank	Comb
Leghorn	White	White	Small	White	Yellow	Single
Langshan	Black	Black	Large	Brown	Blue	Single

Make such observations and calculations as are necessary to answer the following questions:

1. What is the earmark by which you can recognize the following breeds of poultry:—Barred Plymouth Rock? White Plymouth Rock? White Wyandotte? White Leghorn? Buff Orpington? Ancona? Black Langshan? Light Brahma? Rhode Island Red? (These are common breeds and may be found in most localities.)

2. What is the difference in the average weight of five Plymouth Rock hens and five White Leghorn hens?

3. How many points on the comb of the White Leghorn? (Count the points on several and average the number.)

4. What is the difference between the comb of the Wyandotte and that of the Plymouth Rock?

5. Does the color of the legs vary among individuals of any one breed? Do all breeds have legs of the same color?

6. What is the color of the eggs produced by Leghorns? Of those produced by Plymouth Rocks? Langshans? Brahmas? Rhode Island Reds?

7. What is the average weight of a dozen eggs produced on your farm? (Weigh several dozen and calculate the average weight.)

8. What is the average production per hen on your farm for the month in which this study is made?

Facts to be Studied

Groups of Chickens.—All chickens may be grouped according to the purpose for which they are kept. Some chickens are raised mainly for eggs, so they are grouped together and called the egg type, while others are raised for meat and are called the meat type. Such chickens as the Plymouth Rock are raised for both purposes and are called dual-purpose chickens. There are other types, such as the ornamental birds.

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Fig. 40. Barred Plymouth Rock rooster

These general types are divided into smaller groups. Most boys and girls are familiar with such terms as Leghorn, Plymouth Rock, Rhode Island Red. When the term Leghorn is mentioned, we think of a group of chickens in which the individuals are much alike. The birds of this name are small, slender, neat, active, have large combs, and lay white eggs. Such a

group of chickens is called a *breed* and the individuals belonging to a breed are very much alike in form, size, activity, and color of egg. But there are White Leghorns and Brown Leghorns, which suggest that even the breed may be divided into groups. The groups which are distinguished by color are called *varieties,* thus, the White Leghorn is a variety within the Leghorn breed. Even smaller groups called *subvarieties* are characterized by such an earmark as the comb. There are rose-comb White Leghorns and single-comb White Leghorns. Thus the single-comb White Leghorn belongs to the egg type, Leghorn breed, white variety, and single-comb subvariety.

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FIG. 41. A WHITE WYANDOTTE ROOSTER WHICH WON THIS PRIZE—A JAPANESE VASE 700 YEARS OLD—AS THE FINEST COCK AT THE MADISON SQUARE GARDEN POULTRY SHOW IN NEW YORK

There are more than 40 breeds of chickens and more than 125 varieties. Compare this number with the number of breeds and varieties which you find represented in your community. Some attention will be given here to the most important breeds.

The American Class.—There are twelve classes or large groups of chickens, but not all are of great economic importance. To the American boy or girl the American group or class is of great interest. This class includes six breeds:—Plymouth Rock, Wyandotte, Java, Dominique, Buckeye, and Rhode Island Red, all belonging to the dual-purpose type of chicken. It is true, however, that egg production is the main purpose which farmers have in mind now when breeding poultry. The American breeds are good layers and at the same time produce a good quality of meat as a by-product as they are much heavier than the chickens of the real egg type.

The Plymouth Rock is the most commonly known breed among this class. The breed was developed just after the Civil War. There are six varieties:—Barred, White, Buff, Silver Penciled, Partridge, and Columbian. They are good layers and mature quickly, the latter fact making them very desirable for meat purposes as they produce early "frys." Egg production is a characteristic which is developed not only by breed but by strains within a breed. The Plymouth Rocks stand high in egg production contests, for there have been egg strains developed to a very high degree of perfection within the breed.

The Rhode Island Red is one of the newest breeds to be developed in this country. The members of this breed possess many very desirable qualities. The eggs are large, have a smooth, brown shell, and are

uniform in size; the birds mature quickly and produce meat of an excellent quality. The red color is very beautiful. The males are darker in color, possessing a glossy dark red plumage which is very desirable from the point of view of the fancier. There are rose-comb and single-comb Rhode Island Reds and a white variety has also been developed.

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FIG. 42. A RHODE ISLAND RED COCKEREL

The Mediterranean Class.—This group of chickens includes the Leghorn, Minorca, Ancona, Andalusian, and Spanish breeds, the most common being the Leghorn. The Leghorn lays large pure white eggs. The birds are much smaller than the American breeds, weighing less than five pounds, and are not so much in demand for meat purposes. They are very active, are good foragers, and are excellent producers of eggs.

The Asiatic Class.—This class is known as the meat class, and includes the Langshan, Brahma, and Cochin breeds. Much attention is being given to breeding these chickens, particularly for meat purposes; but some strains of these breeds are excellent layers as well as good meat producers. These breeds are not so

active as those of other classes. The birds have feathered legs, which distinguish them from most other breeds.

The English Class.—One breed of the English class of chickens, the Orpington, is very popular in this country. There are three important varieties, the Buff, the White, and the Black, all having single combs. They have a bluish-colored shank and the skin is light colored instead of being yellow as is that of the American class. The Orpingtons compare very favorably with the best American breeds in size and egg production.

The other classes of chickens will not be discussed here as they are of less importance than those mentioned.

Review Exercises

1. How are breeds distinguished?
2. Name the American breeds and give some of their characteristics.
3. Give the advantages of a dual-purpose breed.
4. How does the Rhode Island Red differ from the Plymouth Rock?
5. List all the varieties of chickens which you have seen.
6. Describe the different types of combs which you have seen.
7. What breeds have rose combs only?
8. What common breeds have single combs only?
9. How many different shades of color do you find on a Rhode Island Red male?
10. Describe the Orpington.
11. Give your reasons for keeping the breed or breeds which are kept on your farm at the present time. Do you think some other breed might be better? Why?

III

THE BABCOCK TEST

Home Work

A Babcock tester is necessary to complete the records called for in connection with this study. It will not be necessary for each pupil to have a tester but the school should possess one. If there is none in the school, perhaps one may be borrowed from someone near the school. If one is not available, take the samples to the nearest creamery to be tested.

Perhaps each boy has a favorite among the cows owned by his father. The purpose of this work is to learn just what that cow is producing for the family. If time permits, a comparison between this cow and other cows may be made. Each pupil should learn to use the Babcock test.

Weigh the milk each morning and evening at milking time and record the weights. Do the cows give more milk in the evening or morning? Why? Is the test the same at both milkings?

Mix the milk each time by pouring from one pail to another, then take a small sample of the milk and place in a wide-mouthed bottle. Label each bottle with the date and time of milking, and amount of milk, thus:—

March 20, A. M.; 22 lb. How much time is required for this work on each occasion?

Test each day's sample with the Babcock test. Does the test of the milk vary from day to day? Is the milk which is most yellow always the richest in fat?

At the end of the week, tabulate the results in the following form:

Cow_____ Pupil's Name_____

Date		Lb. Milk.	% Fat	Lb. Fat
_____	A.M.	_____	_____	_____
	P.M.	_____	_____	_____
_____	A.M.	_____	_____	_____
	P.M.	_____	_____	_____

Does the cow with the largest udder produce the largest amount of milk? What is the total amount of butter fat produced by all the cows on your farm in one day?

What is the value at current prices of the butter fat produced by the cow you tested for one week?

What is the average test? (The average of the percentages will not give the average test of the milk. Why?)

How much butter will she produce in a week? (Multiply the amount of fat by 1⅙ to get the amount of butter.)

Suggested supplementary home work:

(a) Take a sample from each of the cows at home for one day; make a test of each sample. Compare

the percentage of butter fat in the milk produced by various cows.

(b) Weigh the milk from each cow for one day and compare the amounts of butter fat produced and suggest reasons for this variation. What is the length of time since each cow freshened? Does the length of this period seem to have any effect upon the percentage of fat in the milk?

Facts to be Studied

What Is the Babcock Test?—The Babcock test is a test designed to determine the amount of butter fat in milk without having to go through the process of churning all the milk and weighing the butter. Milk which is sold to the creamery is usually bought on the basis of the amount of butter fat in it. Thus the Babcock test has come into common usage for the purpose of testing milk.

Sampling.—The fat content of a cow's milk varies from milking to milking and it is necessary in order to get an average test to test a number of milkings. A mixed sample may be made by placing a sample of each of a number of milkings in a pint Mason jar. The sample taken may be small, but should be proportionate to the amount of milk given. Thus, if the cow gives 20 lb. of milk in the morning and 30 lb. of milk in the evening, the sample taken in the evening should be one and one-half times as large as that taken in the morning; two tablespoonfuls to each 10 lb. of milk is enough.

A mixed sample made up of several individual samples is called a "composite" sample.

How Much Should Cows Produce?—The Babcock test is used in establishing official records of dairy cows and these records are reported by the breed associations. The world's record for one year's butter fat production is held by a registered pure-bred Holstein-Friesian, Bella Pontiac. The milk she produced in one year was tested by the Babcock test and found to contain 1,259 lb. of butter fat. The importance of this test in building up the dairy industry can scarcely be overestimated. By testing each cow's milk the farmer can learn which of his cows is doing the best work for him. He can find the cow or cows which are loafing and not paying for their board and by selling these cows and keeping the best ones for breeding purposes a farmer can breed up his herd to a high standard of production. A good standard to set up for cows in the dairy herd is 12,000 lb. of milk each year. There are many herds which reach this standard.

Testing Whole Milk

University of Illinois Experiment Station, Circular Number 174

"The sample to be tested should be at a temperature of 55° to 65° F. Mix the milk thoroughly by pouring it a number of times back and forth from the sample bottles into a clean vessel, taking care that all curd or

undistributed lumps of cream are broken down. Immediately after mixing, draw the milk up above the mark on the pipette and hold it there by quickly placing the forefinger over the end of the stem; release the pressure of the finger slightly, allowing the milk to run down to the mark (this is easier to do if the finger is dry). Then transfer the pipette of milk to the test bottle, allowing the milk to flow slowly down the neck of the bottle and blowing the last drop into the bottle. The best results are obtained when the pipette and the test bottle are held at a slight angle during this transfer.

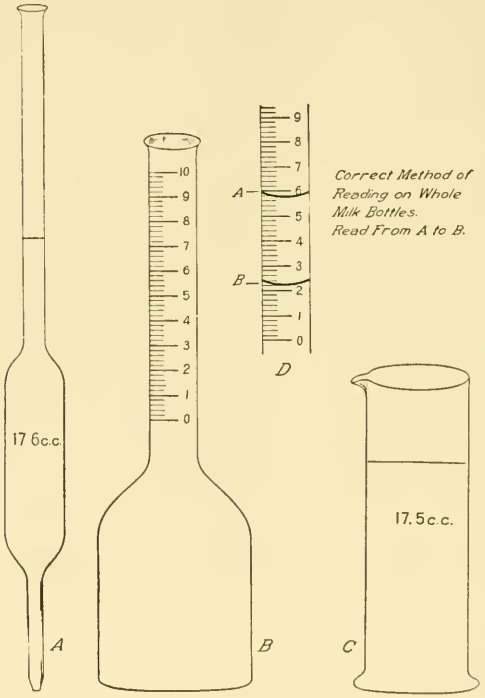


FIG. 43. *A*. MEASURING PIPETTE; *B*. MILK TEST BOTTLE; *C*. ACID MEASURE; *D*. CORRECT METHOD OF READING ON WHOLE MILK BOTTLES. READ FROM A to B

"Do not lose any of the milk sample in the process of mixing, measuring, or transferring, for the Babcock test is essentially quantitative and any loss affects its accuracy.

"After transferring the milk to the test bottle, measure out 17.5 c.c. of commercial sulphuric acid into the small glass cylinder and pour into the test bottle. The acid should be about the same temperature as the milk. Hold the bottle in a slanting position and rotate it slowly so that the acid will run down the narrow neck and carry down any milk adhering to it. After the acid is added, mix the milk and acid with a rotary motion, being careful not to force any of the mixture into the neck of the bottle. Keep up the rotary motion until all the curd has been dissolved and the liquid is of dark brown color.

"When the samples to be tested have been prepared, put the bottles in the tester, taking care to place them opposite each other so that they balance. Turn the crank the required number of turns per minute for five minutes; then, without removing, fill each of the bottles to its neck with hot water and whirl them again for two minutes. Add more hot water to each bottle until the neck is filled to within half an inch of the upper limit of the graduation marks; then whirl the bottles again for one minute.

"If the foregoing instructions have been carefully followed, the neck of each bottle will contain a column of fat which should be of a clear yellow color. The test is now ready to read.

"**Reading the Test.**—The extremes of the fat in the neck of the test bottle are the limits of the reading. The most accurate reading is made when the temperature of the contents of the bottle is 130° F.

"It will be noticed that the scale on the neck of the test bottle has ten large divisions, and that each of these is divided into five small divisions. Each of the ten large divisions represents 1 per cent, and each small division, 0.2 per cent. If the fat column covers three of the large spaces and three of the small ones, the reading is 3.6 per cent. This means that there are 3.6 pounds of butter fat in every one hundred pounds of the milk being tested. The use of a pair of dividers to measure the limits of the fat column will aid in securing greater accuracy in reading the test."

Problems and Review Exercises

1. Of what benefit to the dairyman is the Babcock test?
2. What precautions should be taken in sampling a cow's milk?
3. How much time is required to sample and test the milk of twenty cows each day? Use your own record of time in calculating this answer.
4. What is the lowest test recorded by any member of the class? Describe the cow that produced the milk testing so low.
5. What is the highest test recorded? Describe the cow.
6. What breeds seem to produce the richest milk? The poorest?
7. Give the steps in operating the Babcock test.
8. What precautions should be observed?
9. What is the action of sulphuric acid on the fingers?
10. If it costs $120 to feed a cow for one year, how much butter fat at 70 cents per pound must she produce to pay for her feed?
11. Estimate the cost of feeding your best cow one year using current prices of feed. Does she produce a profit over her feed? What is the calf worth each year?

12. A cow gives 27 lb. of milk daily. The milk tests 4.2% butter fat. How much will the butter fat produced by this cow in one month bring at 62 cents per lb.?

13. The daily production of John's cow is 22 lb. of 5.2% milk. Henry's cow produces daily 38 lb. of 3.6% milk. What is the difference in the amount of butter produced by the two cows in one week?

14. How much cream testing 20% butter fat will John's cow produce in one day? How much will Henry's cow produce?

15. How much cream testing 20% did Bell Pontiac produce in one year?

16. Ten Holstein heifers of a herd owned by the University of Illinois produced in one year an average of 13,542.2 lb. of milk, containing 466.14 lb. of butter fat. What did the milk test? The dams of these heifers averaged in one year 9,533 lb. of milk, containing 300 lb. of butter fat. What was the test of this milk? What is the difference in a year's income between the produce of the daughters and that of the dams if the product was sold at 62 cents per pound of butter fat?

IV

THE SILO

Home Work

The purpose of our study of silos is to become acquainted with the different types of silos and to learn the extent to which they are used. Each member of the class should report on the silos in his immediate locality. By this method facts may be secured about the whole school district. The results may be tabulated according to the following outline:

Name of Farmer	Type of Silo	Estimated Value	Diameter	Height	Remarks	Good Points, Objections, Keeping Qualities, Etc.

In the second column, the type of silo should be given upon the basis of material used in construction as brick, concrete, or wood. If the farmer has more than one silo, record his name twice and describe each

silo. Under "Remarks" include any remarks that you have heard the farmer make about the use of the silo. Perhaps it will be possible to get the opinion of the farmers in the district on the best kind of silo for the community. The table may be extended to include other items suggested in the questions such as the acreage of crops required to fill the silo.

Answer the following questions:

1. How many silos are there in your community?
2. What per cent of the farms have silos?
3. What crops are put into the silos and to what kind of live stock is the silage fed?
4. Obtain some opinions of farmers regarding the investment of money in a silo. Do those who have used silos believe that they are good investments?
5. Approximately how many acres of corn are required to fill a silo 14′ x 30′? Calculate from the data obtained from farmers.

Facts to be Studied

Use of the Silo.—Most boys and girls have seen cabbage cut and packed into a large jar to make sauerkraut. The silo is the dairy cow's kraut jar. Corn and other crops are cut while they are green and packed into the silo where the finely cut material undergoes certain changes by fermentation. The silage, as the feed is called when it comes from the silo, is a very palatable feed and takes the place of the green feed which the cows and other live stock have been eating during the summer months. For this reason silage is

usually fed during the winter months when pasture is scarce, although it may be fed in summer with good results.

Advantages of the Silo.—There is much discussion among farmers, as you may have already learned through your home observation, as to the advantages and disadvantages of the silo on the farm. The farmers who are in favor of the silo give these reasons for their opinion:

1. The silo makes it possible to have green succulent feed all the year.
2. There is less labor involved in handling corn through the silo than there is in other methods of harvesting and storing.
3. The feed is in the barn during the winter when the weather sometimes makes it impossible to use shock fodder that has been left in the field or stacked out.
4. Experiments have proved that an acre of corn put in the silo and fed to dairy cows will produce more milk than when harvested and fed in any other way.
5. Stock will eat a greater portion of the corn when it is fed in the form of silage than when fed in any other form; hence, there is less waste through using a silo.
6. More feed can be stored per unit of space in the silo than in the mow.
7. Silage is an economical feed when fed for beef production.

Types of Silos.—Most silos are cylindrical. Many different materials are used in the construction of the various types of silos, a common type being the stave or wood silo. In constructing this type of silo, wood staves are put together by the tongue and groove, and

then held in place by iron hoops or bands, the construction being very similar to the making of a barrel.

Another common type is the solid-wall, concrete silo, the walls being about six inches thick and heavily reinforced with iron rods and netting. The tile or block

FIG. 44. STUDENTS BUILDING A CONCRETE SILO

silo, made of glazed tile or blocks, has come into common usage. The block silo is made of concrete blocks such as are seen in the construction of foundations. Brick silos are also in use.

It is difficult to say which is the best, and perhaps there is no best for all conditions. The peculiarities of local conditions, such as climate, should help to deter-

mine the kind to build. Silage does not freeze as readily in silos having hollow walls as in those with solid concrete walls. Wood silos often blow down or burn, and if the silage is too green when it is put in, the

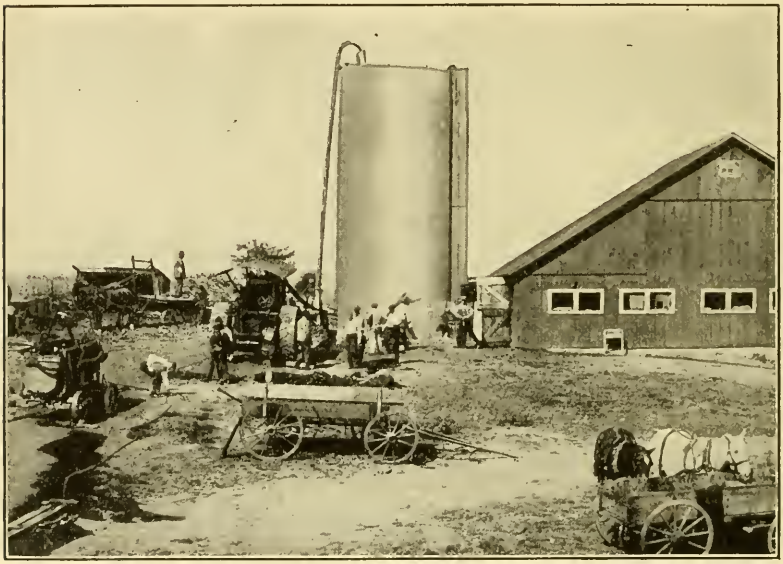


FIG. 45. THE DAIRY BARN AND SILO WERE BUILT BY STUDENTS ATTENDING BLACKBURN COLLEGE, CARLINVILLE, ILLINOIS, WHERE LEARNING AND EARNING GO HAND IN HAND. EDUCATION SHOULD NOT BE SEPARATED FROM HONEST LABOR

wood staves may rot off due to the juices collecting in the bottom of the silo.

The pit silo, built below the surface of the ground like a cistern, is in common use in some sections. The silage must be lifted from it. It has advantages in extremely cold climates and in countries where wind

storms are common. It costs less to construct a pit than to build a silo of the other type.

Size of Silos.—The size of the silo needed on the farm varies with the number of animals to be fed. The silo should be small enough in diameter so that a layer of the silage may be fed from the entire area each day, otherwise the silage will spoil. A silo ten feet in diameter and thirty feet high will hold about fifty tons of silage and will require from four to five acres of corn to fill it. A herd of twelve cattle could be fed from November first to June first from this silo. A ton of silage occupies approximately fifty cubic feet, so the capacity of any silo may be figured.

Filling the Silo.—Corn should be put into the silo when the dent first appears in the kernels. It should be just out of the "milk stage" because if corn is too dry when the silo is filled, it is likely to mold. Water is run into the silo as it is being filled if the corn is somewhat dry. The corn is cut in the field by hand or with a binder and is hauled at once to the silage cutter where it is cut or chopped very finely and blown into the silo. Usually one or two men stay in the silo to distribute and tramp the silage.

Feeding Silage.—Silage may be fed to any kind of stock; however, it is usually considered as a cattle feed. Dairy cows giving large quantities of milk will consume from twenty to forty pounds of silage per day besides a grain and hay ration. Silage is an economical roughage to feed to fattening cattle. In fact, some of

the best gains have been made by feeding a ration of corn silage, cottonseed meal, and alfalfa hay. There is no definite ration which is best for all animals as the needs of the individuals vary. It is not possible to say how much silage should be fed to a single cow without knowing the cow. The farmer should study his animals and feed them according to the needs of the individual rather than follow definite rules.

Problems and Review Exercises

1. What purpose does the silo serve on the farm?
2. At what time of the year is silage usually fed? Why?
3. What method is used in cutting corn for the silo in your community?
4. Name the advantages of a silo.
5. How much silage will be required to feed a herd of twelve dairy cows from the time the pasture is gone in the fall until pasture is ready in the spring?
6. To what kind of live stock may silage be fed?
7. Distinguish between the different kinds of silos.
8. Which kind would you build if you were a farmer? Give your reasons.
9. What is a pit silo?
10. In which kind of silo will silage freeze most easily?
11. How many tons of silage will a silo 12 feet in diameter and 36 feet high contain? (1 ton occupies 50 cubic feet. 1 cubic foot weighs 40 lb.)
12. How much silage will the largest silo in your community hold?
13. Each of two silos are 30 ft. high. One has a diameter one half as great as the other. What per cent of the capacity of the larger silo is the capacity of the smaller one?

14. What will it cost to paint a wooden silo 10 ft. in diameter and 30 ft. in height, at 75 cents per square yard?

15. How many cubic yards of concrete will be required to build a solid-wall silo having an inside diameter of 12 ft. and a height of 36 ft., if the walls are 6 in. thick?

V

MILK AND ITS CARE

Home Work

Compare the milk of the various cows on your farm as to color. Do the cows of the same breed give milk of the same color? Did the Babcock test show that the yellowest milk was richest in butter fat?

Set some fresh milk in a warm place, preferably in the kitchen where the temperature and humidity are high. How long is it before the milk begins to taste sour? How long before it becomes curded or clabbered? Into another sample, put some of the dirt and litter of the barn—about a half spoonful in a quart of milk and compare the time required for souring with the time required by the clear fresh sample. Set another sample in a cold place, the ice-box or out-of-doors if the temperature is low. How long before it sours? Allow fresh milk to remain near onions, cabbage, rotting potatoes, or other foods having a strong odor. Does the milk absorb the odor to such a degree that its flavor is affected?

If you have a separator on the farm, examine it to answer these questions: How many discs in the bowl? Does the cream come out above or below the milk?

If the crank is turned sixty revolutions per minute, how many revolutions does the bowl make? Try to separate cold milk. What effect does the temperature seem to have upon the efficiency of the separator? Can you suggest a reason for this effect? Try to discover the principle of separation of the cream from the skim milk. Does the cream go to the center of the bowl or to the outside when it revolves at great speed? Why? Turn the cream screw one turn to the left and note the effect upon the amount of cream. Then turn the screw to the right and note the effect. Can you suggest a reason for this difference? Name all the makes of separators which you can find advertised in farm journals. Cut pictures from the advertisements and make up a cardboard page of pictures to be used in the class at school. What differences in the separators do you see in the pictures?

Facts to be Studied

Milk is a food product produced by mammals for their young. Most milk contains more than three fourths water. Milk from the various animals contains different proportions of fat and other solids. The milk of the whale is perhaps the richest in fat, containing more than two fifths, about 43 per cent, fat, while the milk of the mare is very low in fat, containing only about 1 per cent or one one hundredth. We usually think of milk as the product of the cow because cow's

milk is used more extensively than the milk of other animals. The cow is an animal that has been bred for milk production. Goat's milk is used in European countries and to some extent in the United States, being used especially in the making of cheese.

Composition of Milk.—One hundred pounds of cow's milk contains the following substances in the proportion given:

Water	87.2 lb.
Fat	3.9 lb.
Protein	3.5 lb.
Sugar	4.7 lb.
Ash	.7 lb.
	100.0 lb.

The proteins include the casein and albumen of the milk; they form curd when rennet is put into the milk. The milk that we drink curds when it enters the stomach through the action of the juices of the stomach upon the proteins of milk. Cheese curd is made up of the solids of milk.

Butter Fat.—The fat of the milk, called butter fat, is the fat from which butter is made. Good butter contains about 83 per cent of pure butter fat. Ordinary cream should contain about 20 per cent of fat, while double cream, or whipping cream, should contain from 35 per cent to 40 per cent butter fat. If you look at milk through a high-power microscope you can see the fat globules. Fat appears in tiny globules or balls

so small that millions of them could be placed side by side on the face of a silver dime. When cream is stirred rapidly, as in churning, these globules of fat unite to make larger grains of fat and finally butter is formed. The size of the fat globules varies. Jersey milk contains larger globules than Holstein milk. For this reason, cream will usually rise more quickly on Jersey milk than on Holstein milk.

Separating Milk.—The fat is lighter than the water and other parts of the milk, and will come to the top when the milk is allowed to stand. When the thick layer on the milk is skimmed off, the product is called cream. The separator separates the fat from the other parts of the milk by a whirling motion. This can be illustrated by swinging a bucket of water over the head. The water remains in the bucket and if a mixture of liquids were placed in the pail, the heaviest would go to the bottom or outside. In the whirling separator bowl, the milk goes to the outside and the cream, being lighter, comes to the middle of the bowl and by means of discs the cream is separated from the milk.

The cream separator is an important device to the farmer as he may separate the milk while it is fresh and warm, keeping the cream for the market, and feeding the skim milk to calves, pigs, or chickens. Skim milk is an excellent feed for growth production and when fed to hens is a good egg producer. The cream separator has made it possible for dairymen to sell fresh cream of almost any desired degree of richness to the consumer.

If a house-wife wishes fresh cream which contains 40 per cent fat, she may get it, and if she wishes cream containing 20 per cent fat, she may get that.

How Milk Sours.—Every boy and girl knows sour milk and its qualities. It is important to know some of the conditions which cause milk to sour. The souring is brought about by the presence of little bacteria sometimes called germs, though not correctly. They are microscopic and can never be seen with the naked eye. These little bacteria are not little animals, as is sometimes thought, but are plants and reproduce at such a rapid rate that within a very short time after they begin growth, millions of them are contained in a single spoonful of milk. These bacteria cause an acid to form in the milk which causes it to taste sour and to curd, causing the condition which we call "clabber." Put a little vinegar in a glass of milk and note the results.

Milk will not sour unless bacteria are present and if we can do anything to check the growth of bacteria we can check the souring of the milk. Milk sours rapidly under the following conditions:

1. In a warm temperature. Bacteria grow rapidly in warm temperatures, thus causing the milk to sour more quickly.

2. In the presence of dirt. The bacteria are taken into the fresh milk by dust particles and dirt from the cow's body, the milker's clothing, or other sources.

Rules for preventing the souring of milk or at least for retarding the souring process may be based upon a

knowledge of the above-mentioned facts and briefly stated as follows:

1. Keep all the surroundings as clean as possible. The cow, the milker, and the milk utensils should be clean. The cow's udder should be washed and dried before milking.

2. Milk with dry hands; otherwise, dirty water and milk will drop from the hands into the milk pail.

3. Wash the milk pails in boiling water and allow them to remain in the strong sunlight as much as possible.

4. Cool the milk as soon as possible after it is milked to check the growth of bacteria. The bacteria do not grow rapidly at temperatures as low as 40 to 50 degrees Fahrenheit.

5. Keep the milk in a cool, clean place.

6. If a cream separator is used, wash it thoroughly after each separation.

7. Utensils which have been used to keep milk for use on the table should be washed in hot water and allowed to remain in the sun before they are used again. In places where certified milk is bottled, the utensils are sterilized with steam which insures that all bacteria are killed before the fresh milk is put into the bottles.

Milk and Diseases.—Frequently epidemics such as the spread of typhoid fever are caused by milk. The bacteria which cause diseases of this kind live in milk when once they are started. The milk may contain tuberculosis bacteria which grow and continue to grow in the body after the milk is used. It is perhaps true that many diseases are spread by the use of impure milk.

Pasteurized Milk.—Sometimes milk labeled "pasteurized" is sold on the market which means that the milk has been heated in order to kill the bacteria

present. By pasteurizing milk in the large cities, the death rate among children has been reduced because the disease germs or bacteria present in the milk are killed by heating the milk to a high temperature.

Evaporated Milk.—Since milk spoils very quickly, there is much loss due to souring and frequently much suffering from want of milk when delivery is held up, as in the case of strikes in the large cities. However, one can purchase canned milk which is milk from which a large proportion of the water has been removed. The water is evaporated from the milk in large steam tanks heated with steam pipes. The milk is then placed in cans and the cans are sealed and are heated to kill all bacteria. Condensed milk is thicker than evaporated milk and is usually sweetened with a sugar syrup to aid in preservation.

The trade in evaporated and condensed milk is extensive, in 1919 the production in the United States being 2,000,000,000 pounds of canned milk. Much of this milk would have spoiled and would have been useless so far as family use was concerned if it had not been preserved in this way. Evaporated milk is convenient to use and serves many purposes in instances where fresh milk cannot be obtained, because it keeps well and can be shipped to distant points.

Products of Milk.—While milk itself is one of the most complete and desirable foods, there are many products made from milk which should be considered. The most commonly used product is butter. Butter

should contain eighty-three pounds of pure butter fat in each one hundred pounds of butter, besides the milk curd, water, and salt. Enough butter is manufactured in the United States each year to supply each man, woman, and child in the country with one hundred pounds of butter. Much is exported to other countries. Cheese is an important product, the most important kinds of cheese made in the United States being American Cheddar, Swiss, Brick, and Limburger. Cheese is made from whole milk and contains approximately one third water, one third fat, and one third curd and ash, the proportion varying in the different kinds of cheese.

Other products—buttermilk, skim milk, whey, and drinks made from these are to be found on the market. Buttermilk and skim milk are excellent feeds for growing hogs and chickens and are widely used as by-products of the dairy industry.

Problems and Review Exercises

1. What differences have you observed in cows' milk?
2. Outline the methods used in caring for milk on your farm.
3. Describe the devices used for cooling milk in your community.
4. What disposition is made of the milk from your farm?
5. What will 2,000 lb. of milk be worth at 14 cents per quart, allowing 2.18 lb. per quart? How long will it take the best cow on your farm to produce this amount of milk at her present rate of production?
6. What would the milk mentioned above be worth at 64 cents per pound for the butter fat it contains if it tested 4.3%?

7. Which will contain the larger amount of butter fat, 30 lb. of Jersey milk, testing 5.3% or 45 lb. of Holstein milk containing 3.4%?

8. How much butter containing 83% fat can be made from 120 lb. of butter fat?

9. How much milk testing 4% would be required to produce the above amount of butter fat?

10. How much cream testing 20% fat could be made from the amount of milk required in the above instance?

11. Allow milk to remain uncovered in a closed room or cellar where onions are kept. What happens?

12. How much milk is produced daily on the farms represented in the class? If all the milk were sold on the basis of the butter fat it contained, what would be its value when butter fat is worth 67 cents per pound?

13. What facts have you learned in this lesson that you can apply immediately? Why?

14. Under what conditions will the purchase of a cream separator be economical?

15. Will it pay better to sell the milk at $3.40 per hundred pounds or at 70 cents per pound for the butter fat if the milk tests 3.8% fat, thus saving the skim milk for house use and for feed?

VI

FEEDING ANIMALS

Home Work

In this study, you should consider some of the common methods used in feeding animals in your community.

1. List the purposes for which animals are fed, such as to do work, to produce milk, meat, etc. Do farmers give the same kind of feed for each purpose?

2. Find out all you can about the amount of pasture required for each animal and estimate the value of pasture land.

3. If you are feeding hogs, place some timothy, clover, and alfalfa hay in the feed lot at different times. Note which hay is eaten eagerly by the hogs. Does this suggest means of improving the feeding of hogs?

4. Many farmers feed corn as the chief grain for horses. Weigh the corn and other grain required for each horse for a few days and calculate the grain required for a year. Make a similar calculation for roughage required.

5. Compare the amount of feed required by milk cows and by work horses.

6. Do poultry eat as much feed per hundred pounds of live weight as other live stock? Weigh the amount of feed given to the flock and estimate the weight of the flock. In this way find the amount of feed eaten for every 100 pounds of live weight.

7. Compare the horses on different farms. Are they all in good condition? What causes such differences as you may notice?

Sometimes we can find horses whose coats shine, while others have rough coats. If you can find such horses, try to learn the difference in the feed which is supplied.

Estimate the total amount of the different feeds used on your farm in a year. Your father can help you to make a close estimate. When each pupil has made this estimate, the results should be tabulated as follows:

Farm	Kind of Feed	Amount Fed	Approximate Value

Total number of farms_____
Total different kinds of feeds_____
Total amount fed on all farms_____
Total approximate value_____

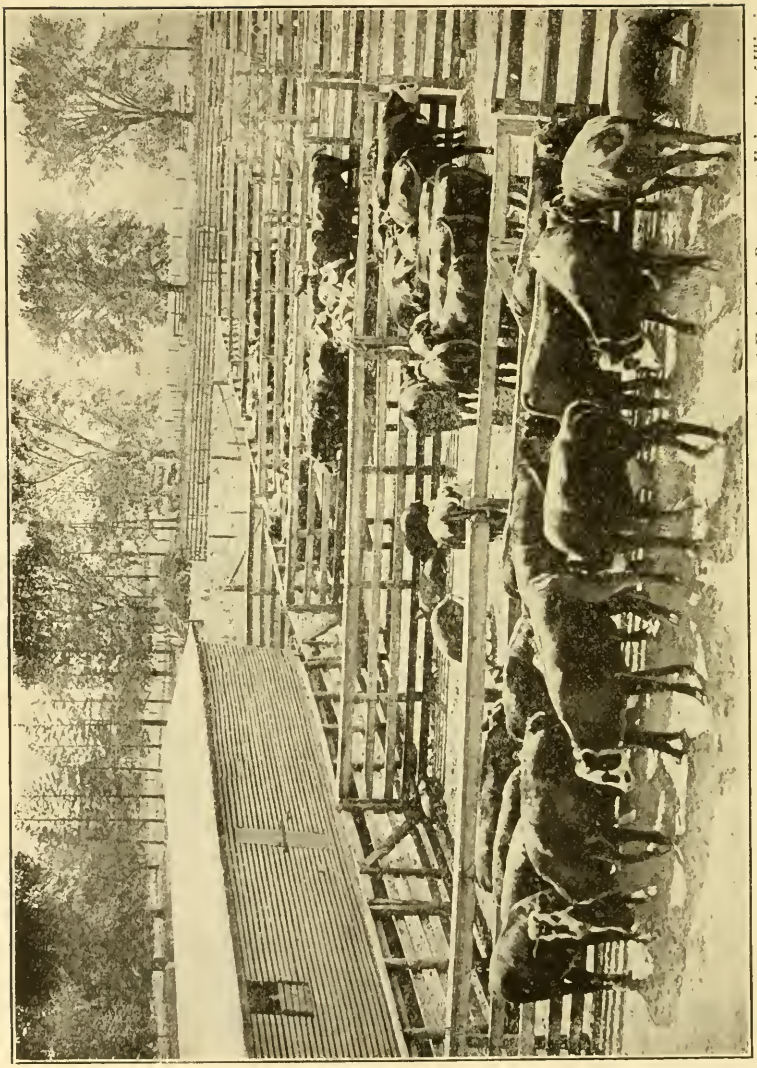
Facts to be Studied

The Animal as a Factory.—As we study domestic animals, we will think of each animal as a factory. We may illustrate what we mean by using as an example, a plow factory. The plow factory must have plenty of room, plenty of machinery, and raw material enough to supply the workroom before it can turn out plows. If the factory is to make plows, it must first of all install efficient machinery; and, of course, the more room it has, and the better the building, the greater capacity there

will be for work. After the machinery is installed, it must then look to the mines for coal and iron and to the forest for wood from which to manufacture its finished product. Important changes go on within the manufacturing room and when the finished plow comes out, it does not resemble to any great degree the coal, the iron, or the wood, all of which were used in making it. Just so, the animal must obtain much raw material and work it over into products which do not resemble the raw material used. For instance, the cow takes raw material in the form of food into the digestive apparatus, works it over, sends it to the udder, which we may call the finishing room, and there manufactures milk and turns it out as a finished product. With this illustration in mind, we can better appreciate the necessity of taking many factors into consideration if we are to study properly the individual animal.

Form and Purpose.—First of all, it is necessary that the individual animal be built for specific purposes, that is to say, the dairy cow should be built for the production of milk, while the beef animal should be entirely different in form because it is not the specific purpose of this animal to produce milk, but to produce meat. The race horse is quite different in form from the heavy draft horse. This is necessary because the work done by the two horses is quite different.

We will suppose that each pupil in the class takes for his problem the management of one of these animals or factories we have talked about. It is evident that



Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 46. STEERS IN FEED LOTS (EXPERIMENTAL)

he should choose a factory that is well built and is shaped for its particular purpose.

Capacity.—The next factor which must be considered is that of capacity. This is a factor which makes for milk production. If the cow has not the capacity for large consumption of food, she will fail to turn out enough milk to make her a profitable factory. Capacity for food consumption is generally indicated in the animal by the open face, broad muzzle, or mouth, and especially by her large barrel capacity, the barrel being that part between the front and rear quarters. It is evident, then, that in order to get the best results, each boy must select an animal which has a capacity great enough to consume a large quantity of food.

Quality.—One other fact should be noted: ability to consume food is not always indicated by size. Thus the engine does not necessarily work most efficiently and most economically because it is large, for a smaller engine may consume less fuel yet work with greater efficiency than the large one. *Quality* is another characteristic which must be considered. The automobile engine is smaller but runs much faster and more smoothly than the tractor because it is of better quality.

Production.—To continue our illustrations, the dairy cow might be built for dairy purposes and might have a large capacity for food consumption and yet be so limited in her udder capacity that the maximum milk production would not be sufficient to make her profitable. This last factor we may call capacity for pro-

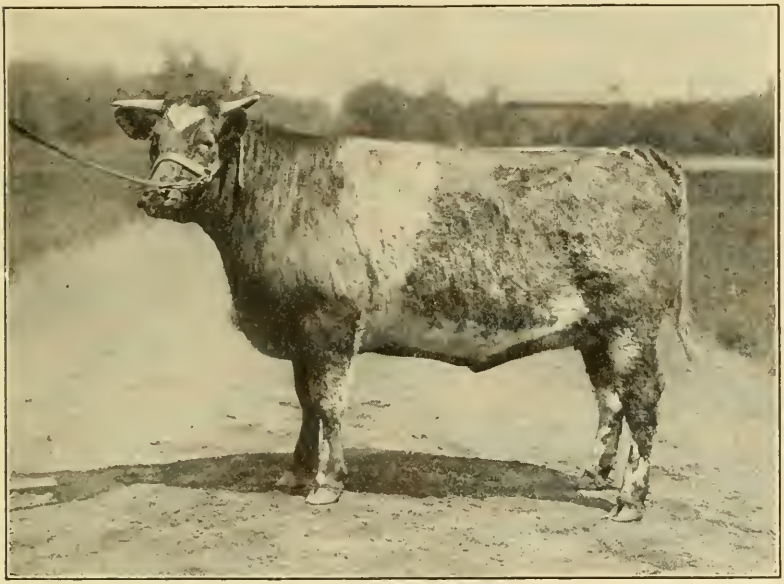
duction and it is best indicated by actual test. The only real test for speed in a race horse is the time which it takes him to cover a given distance; in the same way, the only real test for the capacity of the dairy cow is the amount of milk and butter fat which she actually produces, which may be determined by the Babcock test, and scales.

The Raw Material Needed.—The man who manufactures musical instruments must select with great care the wood which goes into the finished product, because the value of the instruments depends largely upon the kind of wood used. He would not choose the same raw material as does the man who manufactures plows. Thus the man who feeds animals must consider the product which he wishes to obtain. If milk is to be the finished product, he should use one kind of feed; if increased fat is the finished product looked for, he will use a different kind of feed. Thus corn is a good fattening feed, while alfalfa, silage, and bran are better milk-producing feeds.

Food Nutrients.—All feeds contain the following five classes of nutrients: protein, carbohydrates or starchy materials, fat, water, and mineral substances. All these are necessary for the maintenance of animal life. Milk and eggs contain a large percentage of protein; consequently, in order to get a large production of milk and eggs, it is necessary to feed materials that contain a large amount of protein. Protein also produces growth in the animal and repairs tissues. For this

reason growing pigs and growing calves should be given large quantities of skim milk or some similar food.

Narrow and Wide Rations.—A ration is the amount of feed an animal eats in a day. The term *narrow*



Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 47. TYPICAL SHORTHORN HEIFER. A GOOD EXAMPLE OF AN ANIMAL FACTORY FOR TURNING FEED INTO MEAT

means that the proportion of protein to starchy material is close or narrow, while *wide* means that the proportion is greater. Every food that contains a proportion of protein to carbohydrates of less than 1:5 is called *narrow*. If the proportion is more than 1:7 it is called *wide*. Since corn has about one part

digestible protein to ten parts of digestible carbohydrates we say that corn has a nutritive ratio of 1:10. This means that corn is a rather wide ration and is best used as a fattening feed, rather than for the production of milk and eggs. Some common feeds with their nutritive ratios are as follows: corn, 1:10; wheat bran, 1:4; oats, 1:6; wheat, 1:8; oil meal, 1:2; tankage, 2:1; alfalfa, 1:4; timothy hay, 1:16; oat straw, 1:28.

The Balanced Ration.—We can now consider what is meant by a balanced ration. It means the amount of food material which is best suited to an animal's needs for one day. If the cow must produce a large quantity of milk besides keeping up her body, she will need more food and different food than if she did not have to produce milk. Hens laying eggs do not need the same kinds of feed which they would require to produce fat.

Necessity of a Balanced Ration.—The wise feeder will feed raw material which has the constituents that are contained in the finished product. Corn has a high percentage of starch which is fattening and should be fed to animals when a large amount of fat is desirable. It is a mistake to feed corn alone for egg production because it does not contain enough of the protein which is needed for eggs. Pigs will not grow well on corn alone, because corn does not contain bone material and growth material in large quantity. In an experiment carried on with pigs, one lot was fed on corn

alone after weaning time and another was fed on corn and alfalfa. The pigs in the latter lot each "dressed out" one hundred ten pounds more than the pigs in the other lot. The bones of those fed on corn alone

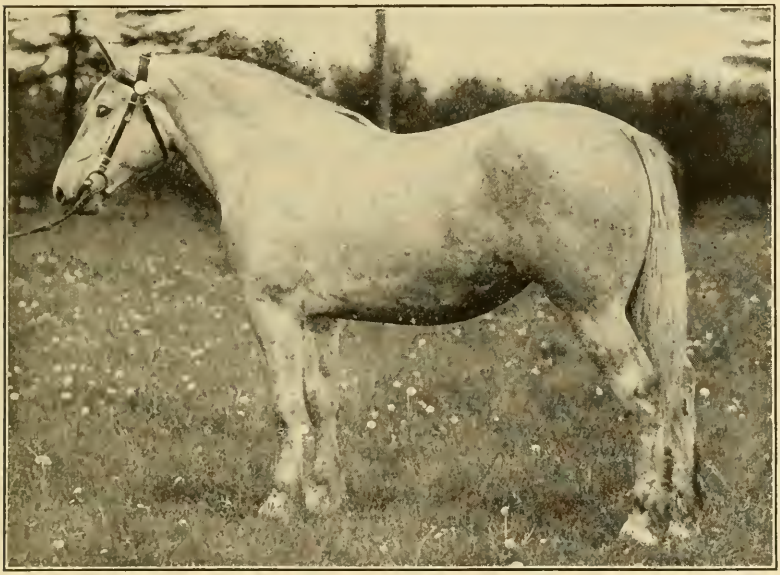


FIG. 48. A TWO-YEAR PERCHERON FILLY. A GOOD FACTORY FOR TURNING RAW FEED INTO POWER

were very weak, not half so strong as the bones of the pigs fed on corn and alfalfa. Many illustrations of this kind can be found.

A plow factory must have steel, wood, and coal, to make plows. No one thinks of making plows from other kinds of materials; still it is not an uncommon

experience to find farmers trying to produce milk by feeding timothy hay and corn, neither of which contain a high per cent of milk-producing food material.

Some typical rations for animals are given below:

No. 1. Ration for cow giving five gallons of milk daily:

Alfalfa	10 lb.	Nutritive ratio 1:6.5
Silage	35 lb.	
Corn and cob meal	8 lb.	
Linseed meal	2 lb.	

No. 2. Ration for 1,500 lb. horse doing work:

Timothy hay	20 lb.	Nutritive ratio 1:9.8
Corn	9 lb.	
Linseed meal	1 lb.	

No. 3. Ration for 200 lb. hogs:

Corn	7 lb.	Nutritive ratio 1:9
Tankage	.25 lb.	

or

Corn	7 lb.	Nutritive ratio 1:9
Alfalfa	1 lb.	

No. 4. Ration for 1,000 lb. steer:

Corn	15 lb.	Nutritive ratio 1:6.2
Linseed meal	3 lb.	
Alfalfa	4 lb.	

No. 5. Ration for fattening lambs weighing 75 lb.

Shelled corn	1 lb.	Nutritive ratio 1:6.5
Clover hay	1.5	
Linseed meal	.15	

Problems and Review Exercises

1. Show in what respects the animal is like a factory.
2. How does the dairy cow differ from the beef cow in form?
3. What is meant by "capacity for consumption"?
4. What is meant by "raw materials"?
5. Explain "narrow" and "wide" rations. Give examples of each.
6. What is meant by "balanced ration"?
7. State the facts and principles learned from the experiment quoted.
8. Name feeds which are good for growth; for fattening.
9. Compare the rations indicated in this chapter with the rations fed on your farm.
10. Explain this statement made in the text: "The wise feeder will feed raw material which has the constituents that are contained in the finished product." Give examples of such materials.

VII

HOW TO TELL THE AGE OF ANIMALS

Home Work

Observations.—The home study should include a close observation of the habits of the animals on the farm and of the anatomy of their mouths. Look into the mouths of the horse and cow and try to determine the number of teeth which each has. Would you expect the horse and cow to differ in the manner of eating grass? Why? Examine the mouth of the sheep. Is it like the horse's mouth, or the cow's mouth? Observe them as they eat to find out which animal picks the grass most closely? Can you suggest a reason for this difference? Observe old and young animals together and list the earmarks which distinguish at once the old horse, the old cow, and the old dog. Can you tell the approximate age of animals by their appearance? A way of testing your ability is to estimate the age of animals on your farm, or on some other farm, then to ask someone who knows to tell you the correct ages. Which one in the class can make the most accurate estimates or guesses?

The Horse's Mouth.—Ask your father to help you to examine the mouths of the horses on your farm.

Note all the differences you can observe. List each horse that you observe, giving the age, the condition of the teeth, and other earmarks as follows:

Name and Color of Horse	Age	Condition of Teeth	Other Earmarks Showing Age
John, Bay	4 years	Corner teeth just appearing	Lively, thrifty, unblemished

Facts to be Studied

Indications of Age.—Some of our farm animals, such as beef cattle, hogs, and sheep, are marketed before they are two years old. Of course, many of these animals are kept for breeding purposes, but the average life is very short when the total number is considered. It is not difficult to tell the age of these animals, because the size and general appearance usually indicate the age. Any one of the class can tell whether a steer is a yearling or a two-year-old by the general development, but the age of such animals can be determined more accurately by the condition of the teeth. The milk teeth, or first set, differ from the permanent teeth, or second set, in size, shape, and frequently in color. Animals shed the milk teeth at a definite age, which is very nearly the same for all animals of a species, but which may vary according to conditions, such as early maturity or differences in feed.

The determination of the age of animals which are used for a longer time, such as the horse and dairy cow,

is more important and also more difficult. The horse's usefulness depends largely upon its age, and horse buyers always "mouth" the horse; that is, they look into the mouth to tell the age.

Sheep.—It is not difficult to tell the age of a sheep when it is under five years old, as, in general, it is true that a sheep is half as many years old as the number of front teeth. Sometimes we hear the expression "a two-toothed sheep," meaning a yearling. The first pair of pinchers, or front teeth of the sheep, appear when the sheep is from twelve to fifteen months old, and the next pair of teeth appear when the sheep is two years old. The others follow at intervals of one year. Thus the sheep is one year old when there are two permanent teeth, two years old when there are four, three years old when there are six, and four years old when there are eight.

Cattle.—It is not so easy to remember the condition of the teeth in the cow's mouth at the different ages. The following table will indicate the condition of the teeth at various ages:

At eighteen months—first pair of permanent teeth, or pinchers.
At thirty months—second pair, first intermediates.
At thirty-nine months—third pair, or second intermediates.
At forty-eight months—fourth pair, or corner teeth.

The cow has a "full mouth," then, when she is four years old. It is difficult to tell the age beyond this period. At six years the pinchers have worn level, and at eight years they begin to show cups in them. The

teeth wear continually, and are good indications of the age of the cow.

If the horns have been allowed to grow, they will indicate the age, as a ring appears on each horn when the cow is three years old. After that time, one new ring appears each year. If the horn shows eight rings, the cow is ten years of age. Try this method at home and check with the known ages of the cows.

Horses.—One can tell the age of a horse by the teeth, unless the teeth have been "doctored" or ground in a way to make them abnormal. When the teeth first appear, they contain deep grooves or cups, and after the horse has a full mouth, the teeth wear rapidly. The cups disappear because of this wearing, disappearing first from the two front teeth in the lower jaw. After that the cups disappear from one pair each year. After the age of ten, the teeth begin to wear down to a three-sided shape and grow longer. At fifteen, the teeth are worn so much that they are usually separated by rather wide spaces.

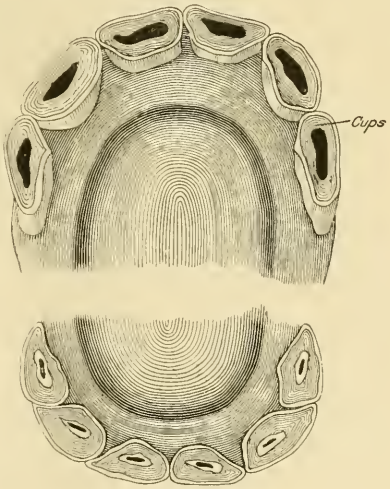


FIG. 49. DIAGRAM SHOWING CONDITION OF HORSE'S TEETH AT EIGHT YEARS OF AGE. CUPS WORN SHALLOW IN LOWER TEETH. UPPER TEETH NOT WORN

The following poem will help to keep in mind the order of eruption and wearing of a horse's teeth, and should be memorized:

The Age of the Horse in Verse

Two middle nippers you behold
Before the colt is two weeks old;
Before eight weeks two more will come;
Eight months, the "corners" cut the gum.

At two, the middle nippers drop;
At three, the second pair can't stop;
When four years old the third pair goes;
At five, a full new set he shows.

The deep black spots will pass from view,
At six years, from the middle two;
The second pair at seven years;
At eight, the spots each "corner" clears.

From middle nippers, upper jaw,
At nine the black spots will withdraw;
The second pair at ten are white;
Eleven finds the "corners" light.

As time goes on the horsemen know
The oval teeth three-sided grow;
They longer get, project before,
Till twenty, when we know no more.

There are some milestones in the life of the horse that are distinctly marked by the condition of the teeth. To learn these few milestones will aid in remembering the details of telling the age of the horse.

At two years of age, the first two nippers or permanent pinchers appear. At five years, a full mouth or full set of teeth appears. At eight, the lower jaw is smooth; that is, the cups are worn from all the teeth in that jaw. The next year the cups wear from the middle nippers of the upper jaw and from another pair each year so that at eleven the upper jaw is smooth, making another milestone.

Problems and Review Exercises

1. The class should arrange the facts gathered from the farm as follows:

Farm (Name)	Horses, under 5	Horses, 5–10	Horses, over 10 Years
Totals			

What has become of the horses over ten years of age? At what age are horses usually sold? What is the best "working age" for horses on the farms?

2. Where do horse buyers ship the horses from your community?

3. Tell how horses are loaded into the car for shipment. How many horses will the car accommodate?

4. How are horses handled and sold in the markets?

5. Are milk cows sold as young as horses? When is a milk cow at her best for milk production?

6. What becomes of the calves that are not kept for the herd?

7. Tell about the oldest horse and oldest cow you have ever seen.

8. Estimate the value of the horses on the farms represented in the class.

9. Has the value of horses increased or decreased during the past decade?

10. Find out at what age the ewes are regarded as too old to be kept on the farm.

VIII

THE HORSE

Home Work

The time spent in studying the horse should be spent in observation for the purpose of finding the answers to the questions listed.

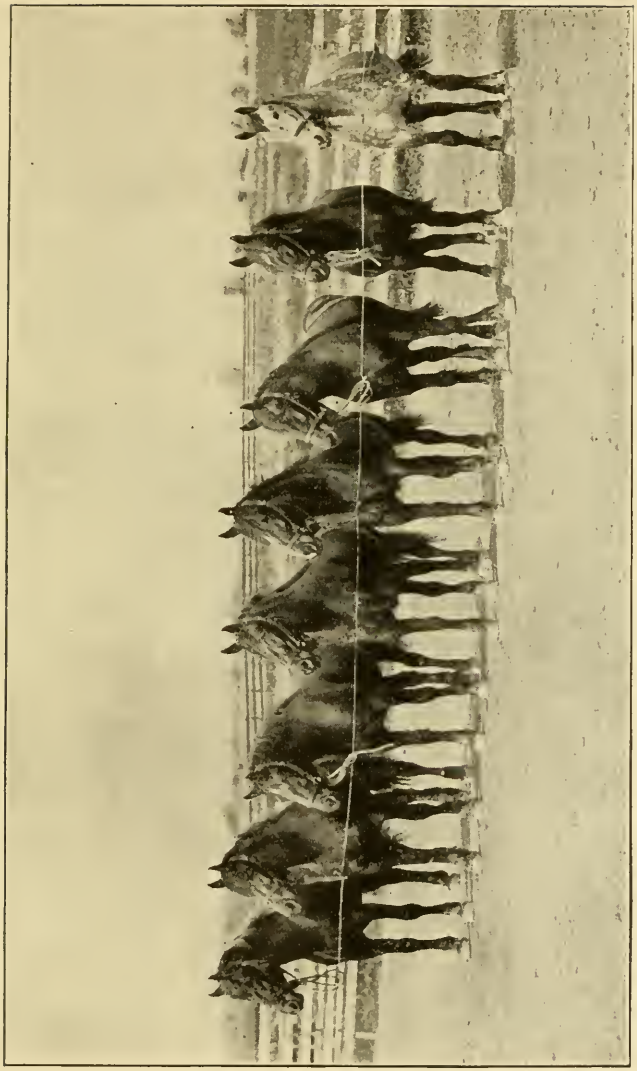
Each pupil should again enlist the coöperation of his father to help him determine the ages of the horses by examining the teeth. If the exact age is known, check the accuracy of the method of telling the age by the teeth. Your father will help you to find such indications of unsoundness as splints, jacks, curbs, ring bones, side bones, and moon blindness. Be ready to give your father's method of determining blemishes. Try to estimate the weights of the horses. If you have a farm scale, weigh some of the horses and check your ability to "guess weights." Make some definite observation to answer one or two of the following questions each day for a week:

1. How many horses are there on the farms which the members of the class represent?
2. What is the average weight of the horses on your farm?
3. What breeds of horses are represented in the community?
4. Who said, "My kingdom for a horse"?

5. How does a horse get up?
6. In what way does the pace differ from the trot?
7. What blemishes and unsoundnesses can you find on the horses at home?
8. What words do your horses seem to understand?
9. At what age should the colt be weaned?
10. How old are the horses on your farm?
11. Estimate the yearly cost of keeping a work horse on your farm, feeding as your father feeds.

Facts to be Studied

The Horse as a Power Machine.—There is approximately one horse to every ten people in the United States. How does this proportion compare with the proportion in your community? There are two main types of horses: the light type and the heavy or draft type. We shall study only the draft type because it is of greater importance than the light type or roadster since the automobile has become so common. Although in some sections the farm tractor has partially replaced the horse as a power machine, it is safe to state that the time is not likely to come when the horse will no longer be needed on the farm. There is still much work to be done which is not adapted to the use of a tractor and since about one horse in five is used up each year, farmers must continually breed horses to keep the supply up to the demand. The horse is distinctly a work animal, and must repay the farmer for the care given him by performing service in the form of



Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 50. TWO-YEAR-OLD PERCHERON FILLIES

work. This means that the farmer should seek horses which are adapted to work. The horse is the farmer's servant and should be cared for in the best way possible.

Breeds of Draft Horses.—The most commonly known breed is the Percheron, its name coming from its original home, La Perche, France. Percheron horses may be any one of a number of colors, the most common colors being black and gray. The horses of this breed are very active, are built close to the ground, and are short and massive in form, with a particularly neat head.

Another breed somewhat similar to the Percheron is the Belgian, a breed which is very popular in this country. The Belgian is of massive build; the neck is short and thick, frequently having a very noticeable crest. The characteristic color seems to be roan, although many other colors are found. The legs are somewhat heavier and coarser than those of the Percheron.

Two other main breeds of draft horses are found in the United States, the Clydesdale originating in Scotland and the Shire coming from England. Both of these breeds are distinguished from the first two mentioned by the heavy "feather" or hair on the legs. Both breeds usually have white points on the legs and face. The Shire is perhaps the heaviest of the draft breeds.

Some Earmarks of a Good Horse.—The work horse should be sound, with legs that are clean and free from

blemishes. A most important part of the horse's anatomy is his foot, which should be large and sound with a strong healthy shell on the hoof. Sometimes the hoof is flat, exposing the heel to the rough ground, causing lameness. This is more likely to be true of draft horses than of light horses.

The horse must have a strong muscular body if he is to perform the work which is set for him. The quarters should be well muscled and the body should not present the long, lanky, and awkward form that is sometimes seen. Occasionally we hear the remark about a horse, "there is too much daylight under him" which means that he is "long coupled" and stands high off the ground, which is undesirable. The disposition of a horse can usually be determined by looking into his face. Those which are small, squint-eyed, and weasel-faced should be avoided. The neck should be muscular and rather high, the low-necked or "ewe-necked" horse being undesirable. The general appearance of the horse is a good indication of his value. Quality stands out in the coat, the eye, the mane, and tail, and in the action of the horse. A large clear eye, a silky coat, and a long tail indicate desirable quality.

"Horse Sense."—This expression is familiar to all boys and suggests that the horse is able to get along fairly well if allowed to do as he pleases without interference. Farmers sometimes say that when driving on a dark night, the best policy is to let the horse pick the road. At any rate, horses are very sensitive creatures, as

every boy on the farm knows. The language used in guiding the horse is familiar, the terms "Get up," "Whoa," "Gee," "Haw," "Back, "and" Steady" being common expressions of the driver. Horses are very sensitive to the touch. Riders guide and direct the actions of their steeds largely by touch, using a stick, the hand, the reins, the leg, the spurs, or the movement of the body in the saddle. We should respect this sensitiveness of the horse by giving him kind treatment.

Care of the Horse.—The horse will respond to kind and thoughtful care. He also responds to rough treatment, but not as we should like to have him do. The horse is our servant, consequently, we should do all we can to make his work easy and profitable, remembering that the horse cannot help himself in most cases, but is under our control.

Here is an old verse which tells what the horse will appreciate:

1. "Bear me up the hill,
   Spare me down the hill,
   On the level spare me not,
   But give me drink when I am hot."

2. The legs of the horse often get very tired. How good it must feel to him after a hot day's work to have his legs washed and rubbed. In the winter, the mud and ice cause "scratches" if the legs are left without washing.

3. The collar must fit exactly or sore shoulders will result as the "pull" is on the collar. Boys and girls know how unpleasant it is to wear shoes which blister the toes or heels, and a horse must feel the same way when the collar hurts.

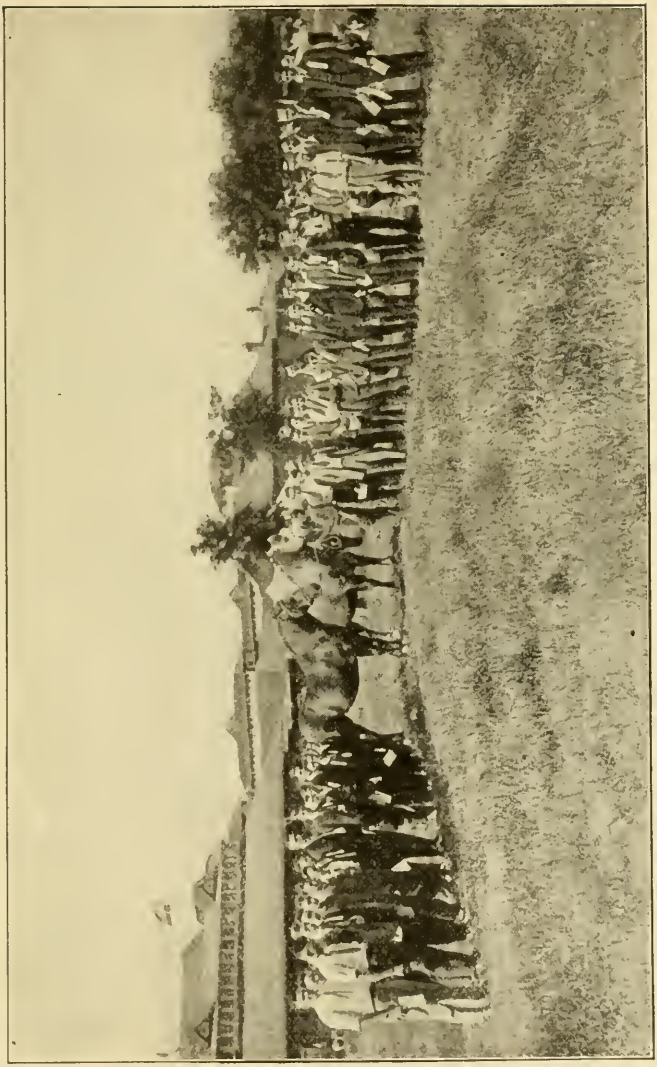


FIG. 51. HIGH SCHOOL STUDENTS JUDGING PERCHERONS, ILLINOIS STATE FAIR, 1919

4. If the hoof is allowed to split and break off to the "quick," how unpleasant it must be. The horse cannot remedy this defect so the master should trim the hoofs and keep the horse properly shod.

5. The stables should be kept clean, for horses as well as people like clean beds.

6. Whipping a horse usually does very little good; a better response may be obtained through kind treatment.

7. Give treatment or call a veterinarian as soon as a horse shows symptoms of illness and do not continue to work a sick horse.

8. The horse always appreciates plenty of good wholesome food; a horse kept in good condition is ready to serve his master willingly.

Some Good Feeds for Horses.—Timothy hay, corn, and oats are the feeds most commonly used. There are other hays, however, that may be used with results as good as or better than those obtained by the use of timothy. Alfalfa hay being richer in protein is better for growing colts and is also a good feed for work horses. Many farmers claim it should not be fed to work horses, but the author knows a number of cases in which alfalfa was the only hay used for horses, and good results were obtained. The difficulty sometimes experienced is due probably to overfeeding. Clover hay is used extensively as horse feed, but clover and timothy mixed is probably better. The horse does not use as large quantities of rough feed as the cow does, but needs a larger proportion of grain. Usually three feeds of grain are given each day.

Problems and Review Exercises

1. Give the distinguishing features of the four main draft breeds of horses.
2. Tell where to locate the following blemishes on a horse: splint, curb, spavin.
3. Give five characteristics of a good horse.
4. What is meant by "horse sense"?
5. Discuss the important items involved in the care of the horse.
6. Why should the collar fit exactly?
7. Why is it important to know the age of horses?
8. Describe the condition of the teeth in the mouth of a horse that is five years old. What is meant by a "full-mouthed horse"?

IX

BEEF CATTLE

Home Work

Each pupil should study the meat production on his home farm and a tabulated statement may be made by combining the facts gathered. Fill in the following blank form:

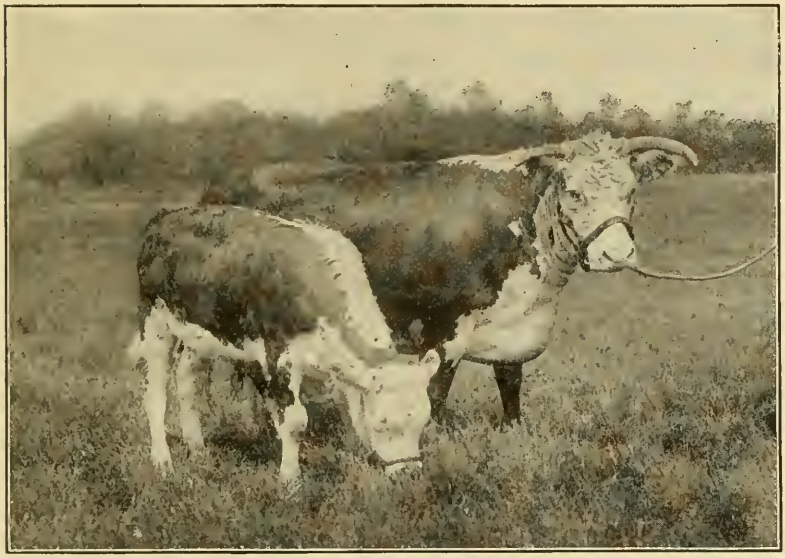
Beef Cattle Survey for School Community

Farm	Number Beef Cattle	Breed	Are Feeders Raised or Purchased	At What Age Marketed	Number Sold Last Year

If possible, visit a farm where a beef animal is being butchered and observe the process. How does butchering beef cattle differ from butchering hogs? What is the approximate weight of the hide from an animal weighing one thousand pounds? What is tallow? To what product of the hog does tallow correspond? What is the "dressing percentage" of a beef animal, that is, what per cent of the live weight is the dressed weight?

At what age are steers marketed on your farm? What method of feeding cattle is used on the farms in the community and what are the principal feeds used?

Compare a beef cow with a dairy cow and list all the differences which you observe. What beef cattle



Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 52. COLUMBIA 11TH AND CALF, SHOWING GOOD HEREFORD TYPE

do not have horns? How many colors of beef cattle have you seen? Can you tell how a cow gets up? Does she get up in the same way that a horse gets up? Can you tell why some farmers prefer to feed their cattle in open sheds even in the winter time rather than to feed them in enclosed barns? Study

the feeds fed to steers in the community and estimate the cost of feeding a fattening steer six months.

Facts to be Studied

Can you imagine a blanket of beefsteak big enough to cover the whole state of Indiana, cities, farms, rivers, and all other parts? Enough beef is produced in the United States each year to make a steak of that size if it could be put into one great steak. The beef cow furnishes us with one of the most important and staple articles of food. She turns her food into meat while the dairy cow converts the food she eats into milk. Consequently beef cows are not great milk producers. It is not possible to produce two products at the same time and produce them in large quantity. The cow must use her food either for milk production or for meat production. A dairy cow is likely to lose flesh as she continues to give milk in large quantities, but a beef cow should lay on fat as she consumes her feed, producing only milk enough for her calf, except in a few instances where milking strains of the beef breeds have been developed.

When Marketed.—Beef cattle are marketed young because the beef products from a young animal are of much better quality than those of an older animal. Then, too, it is not profitable to feed a steer for two or three years before he is "finished" for the market because the increase in weight is not sufficient to pay

for the feed and care. Much of the beef is produced from "baby beeves"; that is, from animals of about one year of age which have been fattened for market. Steers from twelve to eighteen months of age are fattened and made to weigh from 1,000–1,400 pounds each, then are sent to market as "baby beeves." It is necessary to have a good grade of cattle in order to produce good "baby beef" at a profit. The results depend upon a rapid increase in weight, hence the best feeders are required for this purpose.

The Range.—It has been a common practice for cattlemen to produce large numbers of feeders, cattle ready to be fattened, by pasturing cattle on wide ranges in the western part of the United States. These feeders are sent to the central markets and are sold to farmers who have grain to fatten them. When they have been fattened or "finished" they are sent to market for slaughter. The ranges are becoming somewhat smaller because of the extension of grain farming into the west, and more cattle are being raised on the farms where they are to be fattened for market.

Feeding Beef Cattle.—Beef cattle may be fattened on roughage or on a mixture of grain and roughage. Good results have been obtained by feeding corn silage and alfalfa hay, with a small amount of cottonseed meal. Corn silage is a most satisfactory addition to the ration. Steers may be fattened on alfalfa alone if no silage is available, as in the case of the western feed lots.

Cattle should receive clover, alfalfa, soy-beans or cow peas. Some typical rations are given below for steers weighing from eight hundred to one thousand pounds:

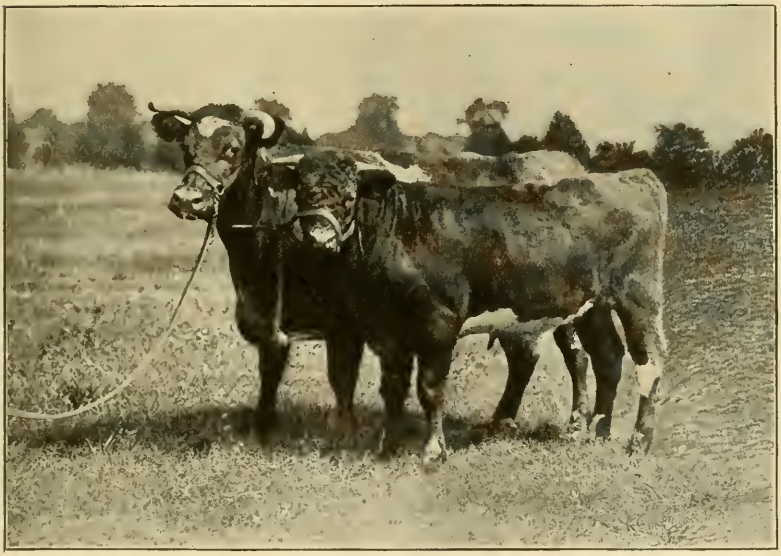
1. Clover hay.....10 lb.
   Corn silage.....20 lb.
   Shelled corn.....10 lb.
2. Alfalfa.....15 lb.
   Corn silage.....25 lb.
   Cottonseed meal. 3 lb.
   Shelled corn..... 5 lb.
3. Mixed hay.....20 lb.
   Corn.....10 lb.
4. Alfalfa..... At will
   Corn silage.....20 lb.

Raising the Calf.—Beef calves are usually allowed to suck the cow until they are three or four months old which gives them a good start and makes a good foundation for "baby beef." The dairy calf is usually taken away from the mother and fed skim milk and some kind of calf meal and a little roughage, because the milk from the cow is too valuable to feed the calf when it is possible to produce a good dairy calf without feeding it the whole milk. If the beef calves are fed by hand they should have whole milk at first in order to insure a good start. They should in either case be given a little grain as soon as they will eat it. A mixture of oats and corn with a little cottonseed meal or linseed meal makes a good feed for the calves that are on pasture and that are getting some milk. If baby beef is to be produced, calves must be kept growing continuously.

Breeds of Beef Cattle.—There are four main breeds of beef cattle and most farm boys are familiar with at least one of the breeds. The main characteristics of

the breeds will be noted here in order that we may learn to distinguish them.

The Shorthorn.—The Shorthorns may be said to be the most popular breed in the United States. The



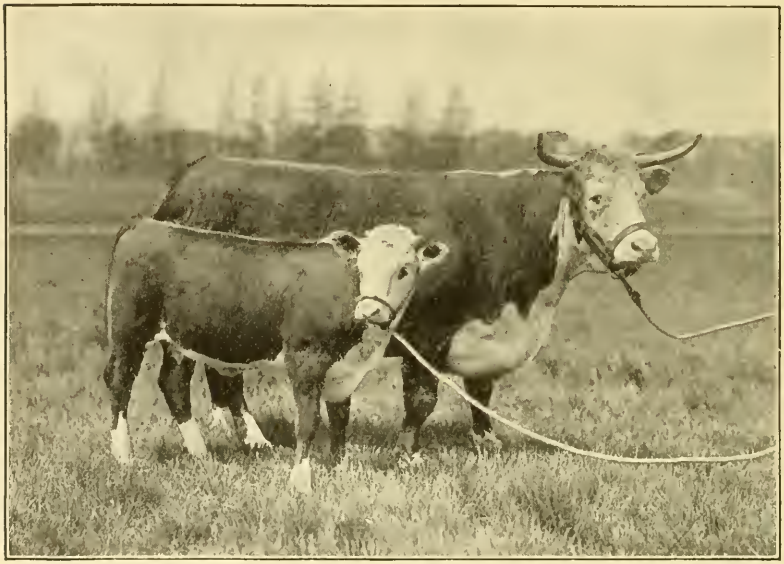
Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 53. REPRESENTATIVE SHORTHORNS. NIAGARA DUCHESS AND NIAGARA LAD

Shorthorns are blocky in form, presenting a rectangular appearance from the side view. The horns are short and are curved forward. The color may be pure white, pure red, or roan. The color is not so distinctive as that of some of the other breeds. Shorthorns are easily fattened and are very well developed

in the parts of the body where the highest priced cuts are found. The breed was developed in England.

Herefords.—These beautiful cattle are red and white in color, having a red body with white face and white



Courtesy of Animal Husbandry Department, University of Illinois.

FIG. 54. SUCH ANIMALS AS THESE HELP MAKE PROFITS ON THE FARM.

underline, and are very popular as grazing cattle. They, too, were developed more than a century ago in England and have become one of the most important breeds. It is said that Henry Clay imported the first Herefords into the United States more than a hundred years ago. The horns are very distinctive, being long and white, turning in or in some cases turning up, slightly.

Angus.—The black hornless Aberdeen Angus cattle came to us from Scotland. They are extremely neat in form and compact in their build. The beef produced is recognized as being of extra good quality. The breed is very uniform in size, shape, color, and general appearance. Fat Angus steers are usually so uniform in size and neat in appearance that they bring the highest prices.

Galloways.—These cattle are also black and hornless. They came from Scotland as did the Angus. The Galloways have a very thick coat of long hair which sometimes has a brownish tinge and is usually curly. They are smaller than the other breeds of beef cattle described.

Problems and Review Exercises

1. State the differences between beef cattle and dairy cattle.

2. If the average dressing percentage of 3,000,000 beef cattle going into the Chicago market during one year is 58%, what is the weight of the carcass beef, assuming an average live weight of 1,050 lb. per animal?

3. If yearling steers make an average gain of 1.75 lb. daily, how many days must they be fed to gain 340 lb. each?

4. If the average shrinkage due to shipping is 40 lb. per animal, what is the total loss to shippers who ship 3,000,000 cattle to Chicago during a year? What is the value of this shrinkage at 13c. per lb.?

5. If steers gain 1.8 lb. per day, how many days' feed is lost when they shrink 40 lb. in shipping? (A part of the margin between the local buyer's price and the market price is to cover the shrinkage.)

6. What breed of beef cattle do you like best and why?

7. Find the total receipts of cattle at the following markets each day for one week: Chicago, St. Louis, Kansas City, Indianapolis, Cincinnati. Can you suggest a reason for the differences among the cities? On what day of the week is the largest number received at the markets? Why? (Consult the market reports in a daily newspaper.)

8. At what age are most of the cattle in your community marketed?

9. Make suggestions for improving the rations fed to beef cattle in your community.

10. If 20 head of steers are fed a ration of 10 lb. mixed hay, 15 lb. of corn, and 2 lb. of cottonseed meal each day for 30 days, what is the total cost of the feed at your market prices for the feeds mentioned? What would the daily gain have to be per steer to pay for the feed at market prices for cattle? To yield a profit of 20% above cost of feed?

X

THE BREEDS OF DAIRY COWS

Home Work

Make a survey of the community in order to determine the representative breeds of dairy cows in the community and the number of each breed. Each member of the class should be responsible for his home farm and another on the road to school.

Tabulate the results, as follows:

Farm	Breed	Number	Total Amount of Milk Daily

Secure samples of milk from each of the breeds and test with the Babcock tester, following directions given in Section III of Part II. What differences do you find in the quality of the milk? What differences in color markings among the breeds in your community do you find?

Ask the farmers to tell you the advantages of the different breeds of dairy cows. What breed seems to be most popular among the farmers? Give the reasons.

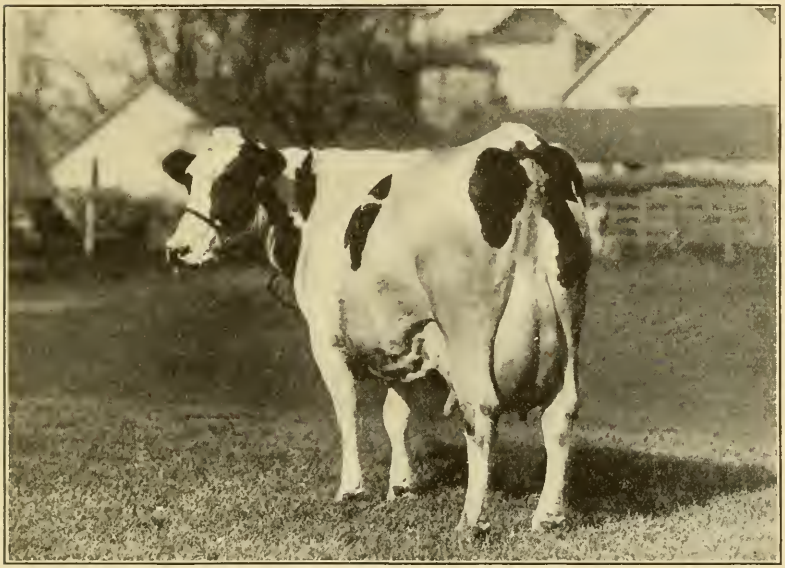
Facts to be Studied

The Breeds.—A breed of cattle is a group, the members of which are similar in form, size, color, and peculiar markings. Much interest has been taken in the United States by the associations representing the breeds of dairy cattle to promote the interests of their breeds. Each breed has its particular good points that merit the consideration of every dairyman. The major breeds of dairy cattle are: Holstein, Jersey, Guernsey, Ayrshire, and Brown Swiss.

The Holsteins.—The Holstein is the most widely distributed breed and is represented by larger numbers than any other in the United States. The breed originated in the Netherlands, coming from the provinces of North Holland and West Friesland. The Dutch farmers have long practiced dairying, producing large quantities of cheese. This breed is perhaps the oldest of the dairy breeds. The land in Holland is valued at very high prices, and the cattle are fed largely upon pasture and hay produced on these rich lands. This may account for the size of the breed. The Holsteins did not get a start in the United States until the beginning of the Civil War, when large numbers were imported. A registry association was soon formed, and the Holstein has continued to grow more popular as a dairy cow.

Characteristics.—Holsteins are black and white in color, most breeders preferring cows with more white

on them than black. The spots may be large or small and may be distributed in any way. In size the Holsteins are large, the cows weighing from 1,200 to 1,700 pounds and the males from 1,800 to 2,200 pounds. The



Courtesy Illinois Experiment Station.

FIG. 55. PIETERTJI PARTHENEA TRITOMIA NO. 234291 PRODUCED 403.6 LB. MILK AND 17.36 LB. BUTTER IN 7 DAYS AND 15,760.7 LB. MILK AND 632.72 LB. BUTTER AS A JUNIOR TWO-YEAR-OLD. SHE IS OWNED BY THE UNIVERSITY OF ILLINOIS.

breed is not so refined and does not look so much like the so-called dairy types as some other breeds, and the cows are rugged and eat large quantities of feed.

Holsteins produce more milk than any other breed but the milk is not so rich in butter fat as that from some other breeds. The Holstein breed holds the world's

record for milk production and for butter fat production. Tillie Alcarta, a Holstein cow of California, has produced more than sixteen tons of milk in one year and more than 1,200 pounds of butter fat, making almost 1,500 pounds of butter produced in one year by one cow.

Many people object to Holstein milk because it is less rich than Jersey milk but part of the difference is due to the fact that the particles of fat in Holstein milk are much smaller than those in Jersey milk and for this reason the cream does not rise so quickly and is not so thick. The cream is also lighter in color than Jersey cream. Holstein milk is very digestible, due to the condition of the fat particles and many people claim that it is much better for babies than the milk of any other cow.

The Holsteins are distributed through nearly all parts of the United States, but are found in larger numbers in the sections producing milk for the large cities. Southern Wisconsin, northern Illinois, and New York State are literally dotted with black and white cattle grazing on the pastures. One county in Wisconsin is said to have more than sixty thousand cows, mostly Holsteins, giving milk for the creameries, cheese factories, and condenseries. The breed is not so widely distributed in the southern part of the country as in the colder sections near Chicago and New York.

Jerseys.—The Jersey breed came from a small island belonging to the Channel Islands off the coast of

France and England. The island of Jersey is very small, containing only about one hundred square miles, but more than ten thousand cattle are kept there. No cattle can be shipped into the island from the outside, unless they are to be slaughtered immediately; thus the breeders have been able to keep the breed pure and to develop it as they wished. Jerseys were introduced into the United States in 1850.

Characteristics.—Jersey cows are small, usually weighing less than one thousand pounds. The main color is fawn, with black markings, and sometimes white spots are found. The Jerseys are the most refined of the dairy breeds, being beautiful animals of very fine quality. The true dairy type is found among the Jerseys as they do not lay on fat easily, and are therefore very poor producers of beef. The Jersey has been proved to be a most economical producer of dairy products, as most of the food eaten is turned into milk.

The milk is the richest produced by any breed of cattle. For family use the Jersey milk is very desirable, as it produces a richly colored thick cream which rises quickly. Jerseys are persistent milkers, which means that they give milk for long periods of time, frequently not going dry from one freshening period to the next.

Jerseys, like Holsteins, are very widely distributed, and are to be found in large numbers on the blue grass

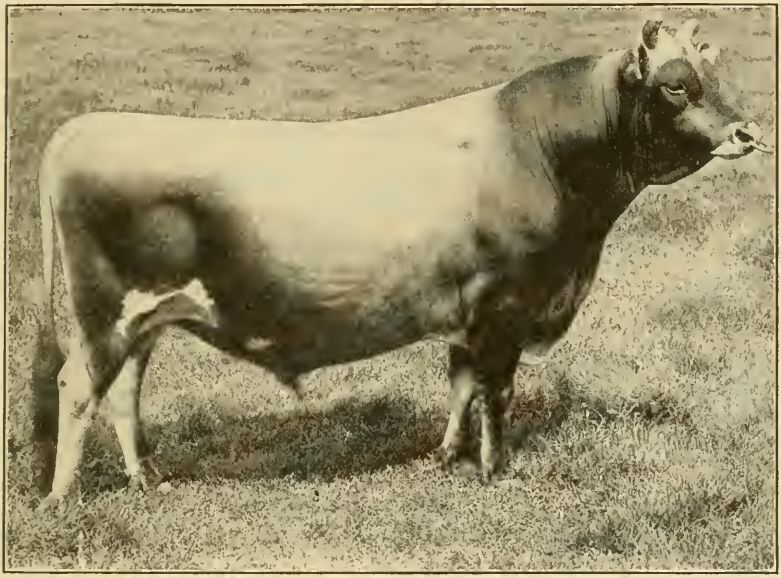
pastures of the South. They are, by nature, not so rugged as the Holsteins, and are better adapted to the warmer climates. The Jerseys are popular for the production of certified milk as the milk meets the requirements as to quality and the cows are easily handled under the strict sanitary conditions required for the production of a high grade of milk.

Guernseys.—The Guernseys were developed in another one of the Channel Islands, the Isle of Guernsey, which is about the same size as the island of Jersey. When the development of the breed began, the cattle were almost like the Jerseys. The breed was brought into the United States about forty years ago, but despite the many good qualities of the breed, it has never become very popular among American dairymen.

Characteristics.—The Guernseys are between the Jerseys and Holsteins in size, the color being a reddish fawn or orange color with white spots. The udders are large with large teats. The cows are not so fine in quality and do not present so beautiful an appearance as the Jerseys. The head is large with a long face, giving the cattle a coarser appearance than that of the Jersey breed.

Milk produced by the Guernsey cows is very rich in fat, almost equaling that of the Jersey in quality. The color is more yellow, giving it a very rich appearance and the cream rises very quickly, making the milk desirable for family use.

Ayrshires.—The Ayrshire cattle were produced in Scotland, being developed as a distinct breed at the beginning of the nineteenth century. They were imported into the United States as early as 1822, but



Courtesy of the American Jersey Cattle Club.

FIG. 56. FAUVICS PRINCE, GRAND CHAMPION, SPRINGFIELD, MASS., SHOW 1919 AND AGED CHAMPION NATIONAL DAIRY SHOW, 1919. HIS FIRST TWELVE DAUGHTERS HAVE AVERAGE PRODUCTION OF 9,576 LB. MILK AND 545 LB. FAT. IT PAYS TO HAVE PURE-BRED LIVE STOCK ON THE FARM.

have never gained the popularity which they seem to merit. Pure-bred herds are found in all the dairy regions, but not in large numbers.

Characteristics.—The Ayrshire is the most symmetrical of the dairy breeds; that is, the body is well

proportioned and the lines are good. The color is red and white. The horns are long and turn upward. The milk of the Ayrshire is of good quality, testing about four per cent butter fat which is less than the Jersey but more than the Holstein milk contains. The color is not so yellow as that of the Jersey milk. It is expecially good for cheese making.

Other Breeds.—The Brown Swiss dairy cattle are large animals, giving large quantities of rich milk. They are most like the beef type of cattle. They are easy milkers and are becoming more popular. As the name indicates, the cows are brown in color, frequently being a greyish brown.

The Dutch Belted cattle are black with a white belt around the body; hence their name. They are not heavy milkers, and are not very popular for milk production in the United States.

The Milking Shorthorn is gaining popularity in sections where a dual-purpose cow is wanted, as the calves make good beef cattle. The milking qualities are being improved.

Summary.—Perhaps no animals have been given so much attention as the dairy cattle, because milk is one of the staple foods of the home. Milk production has been increased to such an extent that it seems as though further improvement could scarcely be expected, and yet each year brings higher records. While it is true that high records have been reached in a few instances, the great mass of dairy cattle have

not approached the largest production. The best year's production from a single cow is more than thirty-seven thousand pounds of milk, but the average production is probably not more than one tenth of this quantity.

Profits from dairy cattle depend upon the amount of milk produced, so the goal of every one interested in dairy cattle of any breed should be higher production. The following records show the maximum yields that have been reached by breeders.

The world's record milk production for one year is held by the following cows representing their respective breeds:

Breed	Name of Cow	Production
Ayrshire	Garclaugh's May Mischief	25329 lb. of milk
Jersey	Passport	19695 lb. of milk
Guernsey	Murmie Cowan	24008 lb. of milk
Holstein	Segis Pietertje Prospect	37381.4 lb. of milk

The world's record fat production for one year is held by the following individuals for their respective breeds:

Breed	Name of Cow	Production
Ayrshire	Lillie of Willowmoor	955.6 lb. of fat
Jersey	Plain Mary	1040.08 lb. of fat
Guernsey	Countess Prue	1103.28 lb. of fat
Holstein	Bella Pontiac	1259.0 lb. of fat

To find the amount of butter produced from the above amounts of fat, multiply the amount of fat in each instance by one and one sixth.

Problems and Review Exercises

1. What are the earmarks by which you can distinguish the Holstein breed? the Jersey? the Guernsey? the Ayrshire?

2. Find the approximate value of all the Holstein cows on the farms in the school community. Of the other breeds.

3. Which breed sells for most money in your locality?

4. Tillie Alcarta produced 33,425 lb. of milk in one year. How many pounds per day did she average for the year? If a quart of milk weighs 2.18 lb., how many quarts did she produce in a year? How many gallons per day did she average? What was the value of her milk at 12½ cents per quart? If it cost $150 to feed her one year, what was the profit over the cost of feed if the milk sold at 12½ cents per quart? How many children would she have supplied with milk daily if each child consumed one quart? How many 50-gallon measures could have been filled with her milk during the year?

5. Duchess Skylark Ormsby produced 1,205 lb. of butter fat in one year. What was her average daily production? How much butter is used daily in your home? If you had owned this cow, how much butter could you have sold weekly above the amount used by the family? (See rule for changing butter fat to butter.)

6. Estimate the total daily production of milk on all the farms represented in the class. What is the average per cow? Will the product yield a profit if it costs $125 a year to feed each cow?

7. Write a composition on one of the following subjects: How I Learned to Milk. The Breed I Like Best. My Favorite Cow. What Should Cows Be Fed?

XI

SWINE

Home Work

Suggestions for raising a litter of pigs are given in another chapter. We shall discuss in this chapter the breeds of hogs.

Make a survey of the school community to determine the extent to which pure-bred hogs are raised and the number of breeds represented. Fill out the following blank:

Farm	Number of Hogs	Pure-Bred or Grade	Breed	Approximate Value
Total				

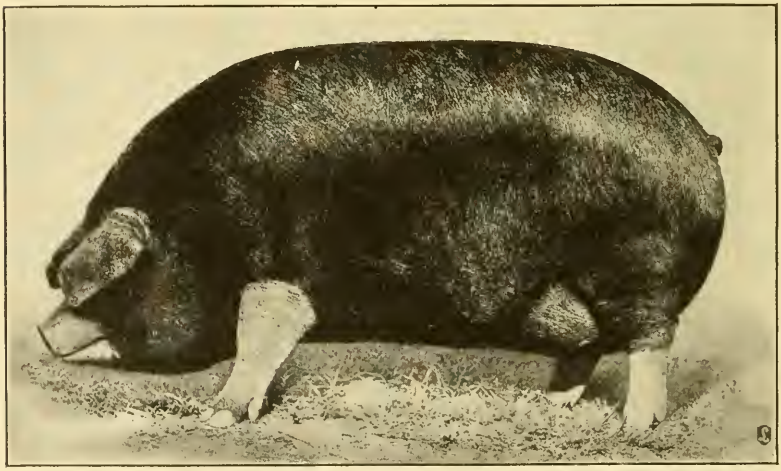
What is the favorite breed of the community? Give some reasons why this breed is the favorite one. At what age are hogs marketed? Do the farmers who own pure-bred hogs like them better than grades? What are their reasons?

Study all the breeds of hogs you can find on the farms on the way to and from school in order to compare

them. Note the differences in regard to the following points: shape of head, way in which the ears are held, general shape of body, color, peculiarities.

Facts to be Studied

Importance of the Swine Industry.—In 1919 there were almost 75,000,000 hogs in the United States. Pork is a staple meat product and the products which



Courtesy Poland China Breeders Association.

Fig. 57. Josephine 1st, No. 738088. Grand Champion Poland China sow, National Swine Show, 1918, at Cedar Rapids, Iowa

come from hogs, such as lard, are necessities. The shortage of fats during the war was an indication of the real importance of these products and the swine industry was increased very rapidly at that time.

More than 10,000,000,000 pounds of pork were produced in the U.S. during 1919. Pork has been much relished as an article of food throughout the history of man. The wild boar was hunted for his meat. The pork industry will ever be a thriving part of the farm business, though the rise and fall of the markets will cause farmers to vary the number of hogs that they keep on the farm.

Breeds.—Every farmer, when he goes into the swine business, has to confront the question: What breed shall I choose? There is a large number of breeds and the choice of any one depends upon the locality and the individual liking of the farmer. A school boy who was a pig club member favored the Chester White as a breed, but he said there was already in the community a Duroc Jersey Breeders' Association that held annual sales and advertised their stock very widely, so he chose the Duroc Jersey breed and began the hog business in coöperation with his neighbors.

There are two main types of hogs: the lard type and the bacon type.

The Berkshire.—These hogs are becoming very popular in the United States. They are black in color with white points on the feet and face. The face is short and very much "dished," giving a peculiar shape and appearance to the head. The breed is generally considered of the lard type although it was originally of the bacon type in England where the breed was developed.

Duroc Jersey.—This breed is one of the most popular of the lard type. The hogs are red in color and are very symmetrical in form. The ears droop over the eye, while the ear of the Berkshire stands almost erect, pointing a little forward. The Duroc Jerseys

Courtesy Poland China Breeders Association.

FIG. 58. GRAND CHAMPION PEN OF BARROWS OVER ALL BREEDS AT INTERNATIONAL LIVE STOCK EXPOSITION, 1918

are good feeders, are quiet, and raise large litters of pigs, all of which makes them popular with the farmer.

Poland China.—This breed was developed in the United States and was intended to be a corn-belt hog of the lard type. It is distinctly of the lard type, blocky in form, and matures very quickly. It has enjoyed more popularity than any other breed in the United

States because it is adapted to a grain-raising country. There are two varieties, the black and white spotted and the black. The black swine are much more commonly found. Some types of Poland Chinas grow to be very large, exceptional ones weighing more than 1,000 pounds.

The Chester White.—These beautiful white hogs have never been so popular as some of the other breeds, though they deserve much credit. The breed was developed in the United States. The hogs are large, belonging to the lard type, but are inclined to be a little coarse.

Bacon Types.—The Yorkshires, white in color, and the Tamworths, red in color, are the main breeds of the bacon type. They are long, rangy, upstanding, and grow to an enormous size. Both breeds are good hustlers or foragers and put on weight rapidly but do not get fat as the Poland Chinas or other lard breeds do.

The Hampshire.—This breed is marked by a white band about the body over the shoulders and front legs. At first it was a bacon-type breed but the present tendency is to develop it as a lard type. These hogs are good foragers.

Other breeds are: the mulefoot, an old breed with a hoof solid instead of cloven; the Victoria, a small white hog; the Cheshire, a white breed originating in New York; and the Essex, a small black English breed.

Review Problems and Exercises

1. How many breeds are represented in your community?
2. Give some reasons for raising a single breed of hogs rather than having a mixed herd.
3. What is your favorite breed? Give your reasons for choosing this breed.
4. What was the average number of pigs in a litter on your farm during the past year?
5. Give some suggestions for the housing of sows and their litters gained from your experience or observation.
6. Give some reasons for the favoritism shown the bacon hog in England while the lard type is most popular in the United States.

XII

SHEEP

Home Work

Habits.—Observe the habits and actions of the sheep about the farm. How does the sheep get up? How does it lie down? What is peculiar about the sheep's mouth? What happens when a flock of sheep is frightened by a dog or some other enemy? How does a ewe find her lamb when it is lost? How can she tell her lamb from the others in the flock?

Handling.—Catch a sheep and examine it to find the answers to the following questions: What color is the skin? How many teeth has the sheep? What is its age? Is the body well filled out with fat or is it long and angular? Estimate the length of the wool fibers. To catch and hold a sheep, grasp it by the neck and hold it by the fore part of the body and do not attempt to hold it by the wool. In making an examination of the body and wool the hands should be kept flat and the fingers together. To part the wool, use both hands with the fingers together; never tear the wool apart with the fingers.

Docking.—If there are lambs on your farm, help your father to dock them when they are from one to two

weeks of age. One person should hold the lamb in his arms with its belly outward while another person cuts off the tail about one and one quarter inches from the body with a sharp knife or a docking iron. Sheep men now use the docking iron in preference to the knife. This iron is a kind of pincers which is heated to redness and used in clipping or burning the tail, thus searing it to prevent bleeding.

Shearing.—Help your father to shear the sheep if you have any. At what time of the year should the shearing be done? How many pounds of wool may be obtained from a single sheep? What price does wool bring on the local market? Describe the process of shearing as you have seen it done. If you do not have sheep on the farm, perhaps you can go to a near-by farm where sheep are kept and make the observations that have been suggested in this lesson.

Survey.—Determine the number of sheep on the farms in your community and classify them as to the different breeds which are represented. Do farmers buy sheep to fatten them or do they raise all the lambs which are fed for market? At what age are the lambs marketed? Find out if possible what handicaps or obstacles the farmers meet in growing sheep in the community? Find out all you can about the laws of your state regarding the treatment of sheep-killing dogs. Describe the actions of a sheep-killing dog and the method which he uses in killing sheep. What was the total value of products sold from the sheep on your

farm last year? Compare this amount of money with the amount received from the sale of other animal products.

Facts to be Studied

Types of Sheep.—There are two main types of sheep: the mutton type and the wool type. It is true that the mutton type produces wool and the wool type produces mutton, but the two types are distinct inasmuch as each is especially adapted to the production of one or the other of the two products. The mutton type is very blocky and plump, having a short compact body that is well filled out, while the wool type is less compact, more angular, and possesses an abundance of fine long wool. In general, we may say that there is the same difference in form between the two types as there is between the beef cow and the dairy cow.

Breeds.—There are so many different breeds of sheep that we shall not attempt to distinguish them in this short lesson. Some of the points which mark the breeds are: kind of wool, covering on the face and legs, color of the face, and the general form of the body. The most important wool breeds are the Merino and the Rambouillet, while the most important mutton breeds are the Shropshire, Southdown, Hampshire, and Oxford. Most of the breeds were originally bred and improved in England. Some other breeds of sheep are the Cheviot, Leicester, Dorset Horn, and Tunis.

A breed that is much newer or younger than those mentioned is the Corriedale, a cross between the two types of sheep. It was first bred in New Zealand and is being improved there.

Earmarks of the Breeds.—While it is not possible to dwell at length upon the many earmarks of the breeds of sheep, a few of the more important distinguishing marks among the common breeds will be listed.

The Southdown: Neat in form; low, blocky, and compact. Face grey or light brown, uncovered below the eyes. The wool covers the legs above the knees. Noted for the neatness of body form.

Shropshire: Heavy, blocky, plump appearance. Face covered with wool, legs covered to the pasterns. Dark brown nose. A very popular mutton breed.

Hampshire: More rangy than the first two mentioned. Face covered to a line just below the eyes. Face and legs very dark brown in color.

Oxford: Larger than the other breeds. Face brown and uncovered below the eyes.

Merino: Face and legs covered with wool. Great folds and wrinkles of very fine long wool covering the entire body. Rather angular in form.

Rambouillet: Larger than the Merino. Face white, covered to the nose. Wrinkles confined to the neck and shoulders.

Where Sheep Are Raised.—Sheep have been a part of the wealth of nations since before the time of Abraham and are now raised in all parts of the world south of

Courtesy of the Animal Husbandry Department, University of Illinois.

FIG. 59. QUARTETTE OF YEARLING SHROPSHIRE EWES BRED BY THE UNIVERSITY OF ILLINOIS

the latitude of the northern boundary of the United States. The regions of greatest importance in the sheep industry are Great Britain, Australia, southern Europe, and South America. Sheep are distributed through all parts of the United States in rather large numbers, but the number per square mile is not so large as the number in other countries mentioned.

Habits.—Sheep flock together by nature and follow their leader, which makes it possible to herd them in large flocks. Flocks of two thousand or more are to be found on the grazing lands of the western part of the United States. Sheep are naturally good feeders and good foragers, which means that they will clean up a field in good shape and will yield a profit by grazing on land which would otherwise be unfit for use. Sheep crop the grass more closely than do cattle or horses, and will eat many weeds which are not relished by other animals. Farmers in the corn belt frequently use sheep in the corn field before husking and sometimes leave them in the field to fatten on the corn.

Importance of Wool.—The importance of wool production for the purpose of manufacturing woolen goods, especially clothing, is often underestimated. The income from wool is usually about one third the total amount of income from the flock. More attention will be given to wool production as the population increases and the demand for woolen goods increases. Farmers in the sections where sheep raising is not the main industry frequently "pool" their wool; that is,

they put all the wool produced in one community together and sell it in a large lot in order to get the best prices for it.

A single sheep will produce from six to forty pounds of wool, depending upon the breed of the sheep and the condition in which it is kept. The average yield is perhaps below ten pounds per head in the United States, but exceptional yields have reached forty pounds. The wool breeds yield more wool per head than the mutton breeds. The long wool is known as *combing wool* and the short wool as *clothing wool.*

Shearing.—Sheep are usually sheared in April or May in the United States, though they may be sheared earlier than this when larger flocks are changed from winter quarters to the grazing grounds. It is better for the sheep if the shearing is done after the weather has begun to grow warm in the spring and the wool is then in better condition as it has begun to "liven up." The power machine is used in most instances for shearing sheep. One who is not an expert can do a neater job and can do it faster with the power machine than with the hand shears. It is necessary to exercise great care not to cut the body and at the same time to get close enough to the skin to get all the wool the first time the shears are run over the body. The wool from a single sheep is called a fleece and is tied in a bundle with the flesh side outward. The bundles are then placed in large sacks and stored until time to take them to market.

Care of the Flock.—It is frequently said that sheep require less care than other farm animals, but if this is true, it is also true that they respond very readily to good care. The fact that they are good foragers makes it possible to turn the flock into wood pastures, corn fields, meadows, or grazing lands and leave them with little further attention as long as they have access to water and salt. On the western ranges one man will herd as many as two thousand head of sheep without the help of anyone except a partner who takes care of the camp and does the cooking. Did you ever wish to go west and become a sheep herder and ride up and down the valleys? Many a young man has had the experience of going to the western ranch to herd sheep only to find it a very monotonous kind of work. In the corn belt, sheep are not herded at all, but kept in small pastures and fed in part on grain and hay. They are provided with good shelter and much care is given to them, especially at the lambing period, as the weather at this time of year is likely to be very disagreeable.

Feeding Hints.—More attention is being given to sheep feeding than was formerly given, because the grazing lands are less extensive. Farmers are not only raising lambs and feeding them for market, but they are shipping sheep from the western ranches and "finishing" them on the grain that is produced on the farms of the Middle West. These feeders, as the sheep are called, may be found on the market in the fall and early winter just when the grain farmer is ready to

feed. Much care is necessary in starting the sheep on a grain ration as they are accustomed to the pasture only. Some hay or other roughage is usually fed at first and the grain is gradually added to the ration. The grain is fed from troughs built low, and the hay is fed from racks. Sheep are very particular about having their food clean and much of the food will be wasted if the farmer is careless and allows the troughs to become dirty.

Sheep are ruminants like cows; that is, they chew the cud, which means that they have four stomachs and re-chew the food after taking it into the first or large stomach. Animals with stomachs such as sheep and cows can make use of large quantities of rough feed. Sheep like almost any kind of hay or roughage, but alfalfa and clover make especially good hay for them because these are very good for growth. Corn silage may be fed to sheep with good results if the silage is of very good quality. When hay and grain are fed for fattening purposes, one pound of grain may be fed to two pounds of hay at the beginning of the feeding period and the grain may be increased until twice as much grain as hay is fed at the close of the fattening period. Sheep seem to make better use of corn when it is fed as shelled corn than when it is fed as ground feed.

Problems and Review Exercises

1. Name the breeds of sheep that you have seen and describe the differences.
2. Describe the two general types of sheep.

3. Mark the farms on the community map where sheep are raised.

4. Ewes in a feed lot ate one hundred and ten pounds of grain and the same amount of alfalfa in ninety days, and gained twenty-seven pounds each. How much feed was required per pound of gain? How much feed was eaten per day?

5. What was the total wool production in your school community last year?

6. Lambs weighing ninety-five pounds each were fed ninety-eight days and gained 27.5 pounds each. What was the gain per day? If they required six pounds of grain and eight pounds of clover hay for each pound of gain, how much of each was consumed daily?

7. Estimate the cost of feeding 100 head of sheep ninety days, using such grain and hay as you have on your farm and figuring the feed at current prices.

8. What would be the value of the wool yield from twenty head of ewes, averaging 8 pounds per fleece, at the current price for wool?

9. When do the sheep become too old to be profitable on the farm? What condition indicates old age in sheep?

XIII

RAISING A PET LAMB

Home Work

Perhaps you can secure an orphan lamb for a pet. Besides the fun of raising it, there may be much profit to be gained. Possibly if the lamb is a ewe, you will wish to keep it and start a flock of your own. The first pet that one of the authors ever owned was a lamb rescued from a cold spring rain after it had been left alone by its mother. It proved to be the source of a new interest in animals.

Facts to be Studied

Birth.—Lambs are usually born in the spring when the weather is likely to be changeable, and when cold wet nights are frequent. Ewes should be given separate pens at lambing time if possible. It will not be strange if some of the lambs seem to be helpless when born. The good shepherd stays near the ewes at lambing time in order to help the little creatures when they are unable to help themselves. The pen should be warm and well protected from the weather, as lambs become chilled very easily. If the day is cold, it may

be a good plan to wrap the newly born lamb in a warm cloth. The first meal is important, and it will be well to help the baby lamb in its first efforts. The young lamb appears as a wabbly creature with more legs than body, and one wonders how it will ever fill out into the symmetrical, playful suckling which it is soon to become.

The Mother Knows Her Own.—When several lambs are in one lot, they sometimes get mixed and the mother loses her lamb and refuses to claim it. One wonders how the mother knows her own when there are hundreds of sheep with their lambs in one flock. The ewe knows her lamb at first through the sense of smell, and after a while she learns to know it by sight. If she refuses to claim it, draw some of her milk and smear it on the lamb and she will soon claim it as her own.

Sometimes ewes disown their lambs several days after birth for no apparent reason. It is then necessary to hold the mother while the lamb sucks, and even this does not always effect a reconciliation between mother and lamb. If the lamb is strong, it will usually take care of itself after a few days, unless the mother becomes actually vicious in her efforts to keep it from sucking. In any case, do not neglect a lamb, but make sure that it is getting the required amount of food.

The Orphan.—A lamb may become an orphan through the death of the mother, or because the

mother positively disowns it, or because the mother does not furnish enough milk. The last reason is sometimes the case when there are twins or triplets. If there is another ewe which can be made to claim the orphan, this is the best way to dispose of it. If a foster mother cannot be found, the next thing to do is to prepare a bottle with a nipple and feed the orphan warm, fresh cow's milk. The lamb should be fed often and given only a small amount at a time, about a tablespoonful at a feeding. Children are apt to overfeed in their anxiety to give the helpless creature enough to start its growth. A pupil in one of the author's classes was given a colt to raise, as the mother had died at the birth of the colt. Too much milk was given during the first twelve hours. The boy did not get up to feed the colt during the night, and the next morning found it dead in the stall. Remember that Nature is very painstaking in feeding the young. After a few days the lamb will be eager for the bottle.

Grain for the Lamb.—Lambs will begin to eat a little grain when two weeks old, and may be induced to nibble at such food even before this time. Especially is this true of the pet lamb after it becomes accustomed to taking the bottle. A little grain in the hand is very tempting to it, but one should be careful not to feed too much, although you will find that the lamb is not so likely to overload its stomach with grain as it was with the milk the first day. After a few weeks it will

be eating a quarter of a pound a day. Crushed corn, wheat bran, and linseed meal make a good grain mixture, containing plenty of protein for growth as well as the required mineral matter which the bran supplies.

Hay and Grass.—The young lambs enjoy frolicking in the yard, and soon begin to nibble the grass, liking it so well that they will eat grass in preference to grain. If they do not get grass, it is well to let them have some clover hay to nibble. Even if they are allowed good pasture, some dry hay may be given to them in the feed rack.

Weaning.—Lambs need to suckle the mother longer than most other young, but may be weaned at the age of four months. If they are allowed to run with the mother, they will suckle longer than this, but it is injurious to the mother to allow them to suckle for a much longer time. We must remember that the mother has had a big strain on her constitution and that she needs a rest. The ewes may be taken away from the lamb abruptly, or the mother and lamb may be separated gradually. The lambs should be on pasture at the weaning time. Lambs at this time will be eating about a half pound of grain daily, and the amount may be gradually increased.

Care After Weaning.—The lambs should be watched closely at this time. Sanitation and good feed are the key words to successful management. The hot

weather of the summer is hard on sheep and the lambs will not thrive in rains and muddy weather. Farmers provide artificial shade and shelter for the sheep during the summer. A prominent sheep breeder in Illinois makes a point of having a shed provided in the pasture which can be moved about to insure sanitation. With a few lambs, there is very little difficulty in providing such a shade.

Enemies.—Sheep are subject to attacks from a number of insects, such as lice, scab mites, ticks, flies, and the stomach worm. Perhaps the last mentioned is the most harmful. The stomach worm is a slender worm, less than an inch in length, which infests the fourth stomach of the sheep, where it sucks the blood from the tiny vessels on the lining of the stomach, causing the animal to become weak, and sometimes causing death. The animal becomes pale and loses flesh very rapidly. These worms are picked up on the grass of the pastures where they live upon the grass until they are taken into the stomach of the sheep. Sheep should not be kept upon the same pasture from year to year if the stomach worm is found there.

When the sheep become infested with the worm, one remedy is a drench of gasoline. This is not a pleasant kind of medicine, so the sheep must be held and drenched with a long necked bottle, care being taken to prevent strangulation. The drench is made by mixing the gasoline with sweet milk. It should be

given in three doses on as many successive mornings, being given after the sheep has been without water or food for a half day. The first dose for the lamb may be made by mixing one teaspoonful of gasoline with about five ounces of sweet milk; the second and third dose may be increased to a tablespoonful of gasoline and five ounces of milk.

At best such remedies furnish only a partial relief and the source of the worms must be removed, or more worms will reach the stomach. The danger from the stomach worm is only another warning to young people to keep on the watch for any trouble that may arise in the flock. When any disease or other disorder arises, consult a veterinarian or some one who can help you to eliminate it. Do not become discouraged, but when disorders arise, make every possible effort to learn the cause and the effect. Perhaps you will be able to discover a means of preventing some of the disorders.

Marketing.—Lambs may be marketed at different ages. Perhaps the boys who have raised lambs will wish to market them as early as possible in order to get early money returns. The lambs should be ready to market at weaning time or soon thereafter. At this time they should be in good condition, as choice meat comes from the lambs marketed at this time. If the lambs are sold at four months of age, there is much less risk to run than if they are kept longer.

Problems and Review Exercises

1. Why should newly born lambs have special care?
2. How would you treat a lamb which was chilled at birth?
3. Tell how to start an orphan lamb on food.
4. How can the mother be persuaded to own a lamb which she has disowned?
5. Make up rations for feeding lambs at the various periods of their lives.
6. Tell how to dock lambs.
7. How may lambs be marketed?
8. At what season are lambs usually born?
9. If you have a pet lamb, keep a record of the amount of milk and other food which you feed it. Determine the cost of raising the lamb and the profit which it yields.
10. Does the lamb have a full set of temporary teeth at birth? Does it have teeth in both jaws?

XIV

RAISING A LITTER OF PIGS

Class and Home Work

The pig clubs of the United States have been among the most popular of all clubs because boys and girls like to raise pigs. The pig is a favorite because it grows into money rapidly and responds quickly to good care and feeding. The nation's need for pork and fats during the past few years, as we have pointed out, has increased pig raising. The club boys and girls have been eager to do their share toward increasing the production of the necessary food products.

It will be well for the class to form themselves into a live-stock club unless the members already belong to a club. If it is thought best not to form a club, each boy and girl may arrange to raise some pigs through the year without the aid of a club leader. If possible, arrange with your father to care for a gilt and her litter until the pigs are ready for market. At least keep a watch over the growth of the pigs and keep such records as are possible. The following suggestions are meant to help you and your father in getting the best results.

Facts to be Studied

Care and Feed.—The bulk of the pig crop is farrowed in the spring when the first warm days come and the remainder are born in the fall. We will assume that the little pigs are born in the spring—March or April.

Fig. 60. One of Loyd's herd. It weighed 50 pounds when it was 50 days old.

When the pigs are young the mother should have good care and feed, and be allowed to run in a lot that is dry and clean. It is sometimes supposed that pigs prefer muddy, filthy places, but this is not true, for they much prefer sanitary quarters and will do better

if they do not have to wade through mud and eat their corn in filthy feed lots. A house that is warm and comfortable will be appreciated by the sows. They should be bedded frequently with straw.

Some sort of green food is necessary to take the place of pasture which is not available. Roots, alfalfa, or pumpkins make good succulent or green feed. The alfalfa is rich in bone and muscle building materials. The grain ration may consist of middlings, corn, and ground oats, with a little tankage added to the ration. Mineral matter is also necessary in large amounts. The story of how one school boy beat his father in raising pigs will illustrate the importance of the proper feed for the mother and the litter.

The father and son chose two gilts each, all from the same litter. The father fed on corn and slop made from the kitchen refuse with a small amount of shorts added. The son built a self-feeder with several compartments; in one he put corn, in another ground oats, and in the others, tankage, limestone, rock phosphate, and a mixture of slack coal and salt. Four litters of pigs were born in April. The mothers had had the freedom of a blue grass pasture and secured such green food as was available in the early spring. The son found himself the owner of fourteen well-formed, strong-boned pigs without a single runt among them. The father saved thirteen pigs from his two gilts, but had three runts in the lot. The father's gilts were fat at farrowing time because they

had had all the corn they wanted. The son's gilts were not fat, but were in good condition and were well grown. The author saw these four litters when they were four weeks old and it was not easy to believe that they were all born within a two-day period. The son's pigs were far ahead of the father's in bone development, in uniformity, and in growth. The friendly contest between father and son was a good lesson to both and the father adopted the ration which the son and his teacher had worked out. He was so pleased with the boy's success that he gave him the two gilts with their fine litters and arranged for him to start a bank account for the purpose of paying his expenses through high school and some day through the College of Agriculture.

Feeding the Mother.—For the first three or four weeks the food of the pigs consists solely of the mother's milk. During this time the mother is essentially a milk-producing machine and should be fed as such. Milk of sows is richer in food solids, particularly fats and casein, than cow's milk. The sow that furnishes milk for an average-sized litter must produce at least one pound of solids in her milk each day. Corn is too fattening and does not contain enough protein to make it a good milk producer. Wheat bran, wheat middlings, skim milk, ground oats, with clover or alfalfa pasture, make an excellent combination for producing milk. The sow should be fed a slop made of middlings or bran, and brought to a full ration gradually.

Feeding the Pigs.—The little pigs will begin to eat with the mother when they are about three weeks old. A trough should be provided in a pen where the sow cannot reach it, but where the pigs can get to it easily.

FIG. 61. A HIGH SCHOOL BOY AND A PART OF HIS HERD. A PART OF HIS LABORATORY WORK IN AGRICULTURE IS GROWING HOGS UNDER THE SUPERVISION OF HIS TEACHER.

A little skim milk or slop made from skim milk and bran or shorts should be put into this trough when the sow is fed. Do not give the pigs more than they will eat at a time. The trough should be kept clean and not allowed to become sour from stale feed, as stale

and sour slops will cause digestive disorders in the young pigs. A little shelled corn should be added to the ration as soon as the pigs will eat it.

Weaning.—Pigs which have had some feed, such as that mentioned, during the suckling period, will be in good condition for weaning at the age of eight or nine weeks. Some farmers wean at an earlier period, but the pigs do not thrive so well. If they run with the sow for a much longer period, the sow will not be in good condition to produce another litter in the fall.

The methods of feeding pigs after weaning time will vary according to the purpose in the mind of the feeder. Pigs that are to be fattened for the market will require different feeds than those that are to be raised for breeding purposes. We will assume that the litter in question is to be marketed for pork.

The first problem of the feeder is to make the pig grow, producing a good framework of body on which to put fat later in the season. Growing pigs need plenty of mineral substance and protein. One hog breeder recommends for the mineral substance a mixture of a half bushel of slack coal, a peck of slacked lime, and five pounds of salt. This should be placed in a box where the pigs can get it. Then, too, feeds which contain much mineral matter should be fed. Wheat and wheat bran contain much mineral matter, but corn does not contain sufficient mineral matter. Alfalfa and clover pasture are excellent feeds for growing pigs.

Rations suggested for growing pigs after weaning are:*

1. Corn.....1 part
   Skim milk.....2–4 parts
2. Corn.....4–6 parts
   Ground oats or middlings.....2 parts
   Tankage.....1 part
3. Corn full feed
   Tankage .4 lb. per pig daily.
4. Corn, tankage, and middlings in self-feeder.

Pigs should be ready for market at from six to eight months of age. At this time they will weigh from two hundred to three hundred pounds if they have been properly fed. No animal is quite so efficient in the process of making meat from grain as is the pig. The exact rations for fattening your pigs will depend upon the feeds which you have on hand or which you can get. A few suggestions are made here to guide boys and girls in feeding the pigs for market.

Corn should never be fed as the only feed for hogs even during the fattening period, as the mineral matter which hogs get from corn is not sufficient and corn is too low in protein to be an all-around feed. If possible, keep the hogs on pasture, alfalfa and clover being excellent pasture. Rape pasture is considered good succulent feed for growing and fattening pigs. The clover and alfalfa are excellent supplements to corn as they balance the ration. A ration of corn, ground oats, and tankage will give good results in the fattening pen. Corn and tankage have given economical results when fed together and if these feeds are put in

**Pig Club Manual.*—"Extension Circular 32," University of Illinois.

the self-feeder, the hog will balance his own ration and make economical gains. Pigs weighing from one hundred to one hundred and fifty pounds will consume about five pounds of grain per day and should gain a little more than one pound a day. Larger hogs require a little more feed per pound of gain.

Vaccination. — Pigs should be vaccinated against cholera. This disease is among the worst of the animal diseases as it claims thousands of hogs each year. Vaccination has proved an effectual check against the disease and a competent veterinarian should be gotten to do the work.

Problems and Review Exercises

1. What breeds of hogs are kept on your farm?
2. What advantage is there in having pigs born in the spring rather than in the fall?
3. Give some rules for feeding the sow before the pigs are weaned.
4. Why is it a wrong practice to feed corn to hogs without other feeds?
5. When should pigs be weaned? How does the weaning age compare with that of lambs? calves? colts?
6. At what age does your father usually market his hogs? How much do they weigh?
7. Estimate the amount of feed which your father feeds to each hog from the time the pig is weaned until marketing time? Calculate the amount of grain fed per pound of gain made.
8. When hogs are selling at 16 cents per pound, how much will 18 head of hogs averaging 260 pounds be worth? If the hogs "dressed out" 70%, what would the dressed carcass have to sell for to bring as much money as the hogs were worth on foot?

XV

SOME GROUPS OF INSECTS

Home Work

Collect insects representing all the classes listed below. The specimens should be mounted on cardboard. If you wish to preserve the larvae, small bottles should be purchased at the drug store. Formaldehyde or alcohol may be used to preserve the larvae.

Insects may be collected by using a sack made of mosquito netting and fastened to a wire hoop to which a long pole is attached.

Observe the insects at work to see how they eat their food.

The following insects may be collected:

1. Butterflies
2. Houseflies
3. Chinch bugs
4. Potato beetles
5. Grasshoppers
6. Honeybees

The insects are representative of the six classes which will be described in the following pages.

Make a table showing the main facts regarding these insects, as follows:

Class	Number of Wings	Character of Wings	Feeding Habit	Where Found	Crops Damaged

In what respect are all insects alike? How many brilliantly colored insects can you find? What reason can you suggest for this coloring? Study the moth and the butterfly. The cabbage butterfly and the cutworm moth are good specimens for this study. How do moths differ from butterflies with regard to

1. Feelers?
2. Position of wings when at rest?
3. Shape of body?
4. Time of day when they fly?
5. General color scheme?

Facts to be Studied

What Is an Insect?—Inasmuch as insects destroy millions of dollars worth of crops each year, we should learn more about them and their methods of doing damage. An insect is a little animal, so called because its body is made up of sections. The word "insect" is derived from a Latin word "insectare" which means to cut into parts. Insects are alike in some respects. All insects have six legs and their bodies are divided into three parts: the head, the thorax, and the

abdomen. There are other peculiarities of insects which should be noted by observation.

Groups of Insects.—Insects may be classified or put into many different groups. They may be grouped according to their eating habits into two groups: (1) those that chew the food; and (2) those that suck the food. More will be said about these two classes in Chapter XVI. Again, insects may be classified according to their relation to man as (1) beneficial and (2) harmful. The scientist has found that insects which have similar wings have similar habits, so he arranges all insects into great groups on the basis of their wing structure. Before making any study of individual insects, we should study the main groups as the scientist arranges them. Not all the groups of insects will be mentioned here, but only the six which include insects of great economic importance to the farmer.

Some insects have *straight wings* and form the group called (1) *straight-winged.* Such insects usually are able to make a noise with their wings. The grasshopper is an example. Every boy and girl is familiar with butterflies and moths and knows that the wings are covered with a powdery substance which comes off very easily. This substance is made up of little scales; hence these insects form the group called (2) *scaly-winged.* The house fly and other flies have two wings and so are called (3) *two-winged.* A fourth group of insects is made up of the bugs which have wings only partially developed. The chinch bug and

bedbug are examples. The group is called the (4) *half-winged* insects. The members of another group have wings which are very thin and film-like, the wings being like silk gauze. These insects are called (5) *membrane-winged.* Bees are good examples. The last group is perhaps the most commonly known of all the insects. The insects of this group have hard shell-like wings, and are called hard-shelled or (6) *sheath-winged* insects. The potato beetle and May beetle are good illustrations of this group.

The Scientific Names.—The scientist does not speak of straight-winged and scaly-winged insects, but gives the groups Latin names. The system of building up these Latin names is based upon a word, "ptera," meaning wing. This word is used in all the names. The Latin prefix added to it usually describes the wings. The prefix meaning half is "hemi," so the word meaning half-winged is "Hemiptera." "Di" signifies two, and "Diptera" is the name given to two-winged insects. "Coleus" means sheath or shell, thus "Coleoptera" is the name given to beetles or insects with hard, sheath-like wings. In like manner, the other words are made up, so the list of the six most important groups appears as follows:

Group	Classification	Representatives
Straight-winged	Orthoptera	Grasshoppers and Locusts
Scaly-winged	Lepidoptera	Butterflies and Moths
Two-winged	Diptera	Flies
Half-winged	Hemiptera	Bugs and Lice
Membrane-winged	Hymenoptera	Bees
Sheath-winged	Coleoptera	Beetles

Importance of Knowing the Classes.—If one knows the class to which an insect belongs, he may determine the life history and habits of the insect, and will be able to suggest methods for its control. All insects go through certain changes, and their "life cycles" will be very interesting and very important to the farmer who wishes to control the insects. For instance, the butterfly lays its eggs on some food plant, preferably the cabbage plant. The egg hatches into a small *larva* or worm, and when this larva is full grown it forms a shell-like structure about itself and goes into what we call the resting stage or *pupa* stage. This pupa does not hatch in the form it had when it went into its resting stage, but after a while it comes out as a full-grown, beautifully-colored butterfly. It is very evident from this, then, that the pupal stage, or the so-called resting stage, was not a resting stage at all, for the insect must have been very active in order to change form and dress in the two weeks' time allowed it by nature.

Insects which have a complete life history similar to this one may be very easily controlled in the "worm" stage. It is in this stage that they eat most food, and consequently it is in this stage that they do most damage to the crops. It is important, then, to know when the butterfly-to-be is in the larval stage, and where it can be found at that time. The cabbage butterfly eats little or nothing as an adult, and therefore does little damage. It is a very difficult task to

keep picking the eggs from the cabbage leaf; and it is not in the pupal stage that the butterfly does most damage, so it is hardly advisable to attack it then. Only when it is about to do most damage can it be fought effectively.

The codling moth lays its eggs so that they will hatch soon after the apples are in blossom. The little worm then crawls into the blossom end of the newly formed apple and remains there. It is important that the farmer should know this in order to know when to spray. If he waits until after the little worm is securely imbedded in the apple, or if he sprays before the moth appears in the spring to lay its eggs, spraying will be useless and no harm will come to the moth.

The potato beetle has a definite life cycle and it should be killed when about to do most damage to crops. But we need to know the life history of the potato beetle, as well as any other insect, in order to know when to strike to do most toward its destruction.

The majority of insects have four complete stages in their life history. The chinch bug, however, does not pass through the same stages as the cabbage butterfly passes through. It does pass through different stages, but they represent a more gradual development. The grasshopper does not have these stages, but is just a small grasshopper when it first comes into existence. Thus we may understand how necessary it is for the farmer to know the life and habits of insects in order to be able to control them effectively.

Problems and Review Exercises

1. Arrange in classes the insects which you know.
2. Give the life history of the codling moth and potato beetle.
3. Write a story telling how the codling moth lives and how it may be controlled.
4. What distinctive marks or features belong to all insects?
5. Name some insects which chew their food and some which suck their food.
6. The class should arrange an exhibit showing specimens of each class of insects studied.
7. Collect information showing the damage done by insects in your community.
8. What damage was done on your farm last year by insects?
9. What birds in your locality destroy insects? Are these birds harmful to the farmer in any way?
10. If ten per cent of the wheat crop in the community were to be destroyed by the Hessian fly, what would be the loss in money at present prices?

XVI

THE CONTROL OF INSECTS

Home Work

The home work will consist of practice in controlling insects. One insect will be used as an illustration. Every boy should arrange with his father to carry out the directions for controlling this one insect. There are few gardens in which the Colorado potato beetle cannot be found almost as soon as the potatoes come through the soil. Sometimes it may be found even before this time. In order to combat the potato beetle, one must know something of its life history. The insect is an eating or chewing insect and hence may be poisoned with Paris green or arsenate of lead. This should be applied with Bordeaux mixture, since the Bordeaux mixture will destroy such fungus diseases as may be present.*

A hand spray will work very well for a small area and for larger areas a barrel spray should be used. It will pay to invest in a spray adapted to the size of the potato patch. If no other spray is available, the hand spray used for spraying cows against flies or a common sprinkling can may be used. It will require much

*These sprays may be obtained at the drug store.

labor, however, to spray many potato vines by these methods. By leaving a row unsprayed, a comparison may be made which will serve as a good demonstration of the value of spraying, but the unsprayed row furnishes a breeding place and only adds to the work of keeping down the damage done. Perhaps a small unsprayed patch somewhere in the community may be compared with others that have been sprayed.

The potato vines should be sprayed thoroughly each week. It is important to spray the under sides of the leaves as well as the upper sides, since the eggs are hatched on the under side of the leaf. This method will prevent the newly hatched larvae from getting a start on the leaves. If Paris green is used without lime or Bordeaux mixture, there is danger of "burning" the foliage of the plants.

Facts to be Studied

Damage by Insects.—Now that we have learned something about the life history and habits of the insects and have begun to appreciate the amount of damage done annually by them, we need to consider the methods by which we can control them. It is practically impossible to stop an army of insects after they have once started their work of destruction in corn fields or on other crops. An army of worms sometimes destroys a clover field in a very short time. Chinch bugs will kill a field of corn in a very short time.

We frequently see stalks of corn that are black with chinch bugs as high as two feet from the ground. All these have come into the corn field in a single day or night after the wheat in a near-by field has been harvested. It is only by checking the development of the insects and by keeping the insects under control that farmers can hope to destroy them effectively.

FIG. 62.—HE IS AS WISE AS HE LOOKS, AND DESTROYS MANY ENEMIES OF THE FARMER SUCH AS MICE AND INSECTS.

Enemies of Insects.—It is true that there are many natural agencies which help to keep the insects under control. Insects are subject to diseases just as people are. There is a disease that kills chinch bugs in a very wet spring season. Following a wet spring, we do not look for many chinch bugs. Some insects prey upon others, thus killing off insects that are harmful to the crops. Birds, too, eat the insects. However, we cannot depend upon the natural enemies of insects to reduce the amount of damage done to our crops. There are some general methods of insect control which have been devised by man.

Destroying the Home of the Insect.—The best way to prevent the damage done by insects is to prevent the insect from hatching. Every farmer can make it unpleasant and very uncomfortable for the insects by cleaning up all breeding places which the insects can call home. If their homes are destroyed, they will eventually be destroyed.

It is the duty of every farmer to work industriously to keep the farm free from such places, for not only will his own crops be damaged but those of other farmers also. It is surprising to know the number of insects which may be housed in a small space through the winter. A hickory nut having a worm hole in it was picked up in the winter and cracked and several hundred chinch bugs were found to be comfortably housed in this mansion of many rooms. Many insects feed upon weeds during the winter months and these could be destroyed if the weeds were not allowed to remain where they could be reached.

Another way to avoid the attacks of the insects is to plant a crop at such a time as to escape a large number of insects. Late sown fall wheat is generally supposed to be free from the damage done by the Hessian fly. In some instances it is better to plant certain crops early so that they will have matured before the insect appears.

Late fall plowing frequently aids very much in destroying the insects which live in the soil during the winter months. Cutworms pass the winter in the

larval stage in the soil and the corn worm passes the winter in its pupal stage. Late fall plowing will destroy the winter homes of these insects and thus becomes an effective method of combating them. Some insects lay their eggs in the soil in the fall and late plowing will expose them to the freezing weather which will hinder them from hatching. Thorough cultivation of the crop and cleanliness about the farm will effectively eradicate the insects.

FIG. 63. "BOBWHITE." THE BOBWHITE INCLUDES IN HIS DAILY RATION INSECTS AND WEED SEED. HE IS KNOWN TO EAT 129 SPECIES OF WEED SEED AND 135 DIFFERENT KINDS OF INSECTS. IT HAS BEEN ESTIMATED THAT A SINGLE BOBWHITE WILL EAT IN ONE YEAR FROM SEVEN TO EIGHT POUNDS OF INSECTS AND TEN TO TWELVE POUNDS OF WEED SEEDS. THIS BIRD SHOULD BE PROTECTED. HE IS A GOOD FRIEND TO THE FARMER.

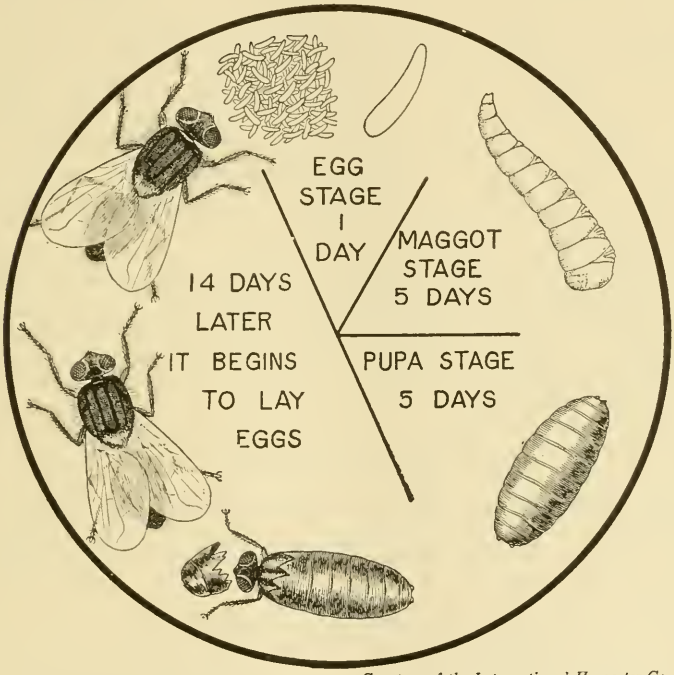
Spraying.—The most common method of fighting the insect is the application of a spray to the crops affected. Apple trees are sprayed with different mixtures, depending upon the insect which is to be combated. Some insects attacking fruits and vegetables

chew their food, and by spraying the plants with poisonous sprays the insects may be killed. Arsenate of lead and Paris green are used for this purpose. Other types of insects do not chew their food at all, but are equipped with little beaks with which they pierce the outer covering of the plant and suck their food. It would be useless to attempt to poison this type by spraying the tree with poison since they do not eat the part that can be sprayed. An effective method, however, of combating this type of insect is to use a mixture of lime and sulphur and spray the tree while this insect is at work. This mixture will cover the insect and harden, thus smothering it to death.

The first spray is called the *poison spray* and the second is called the *contact spray*. Another type of spray sometimes used is called the *repellent spray*. This spray is made up of substances which have an odor which insects do not like, thus keeping them away from the crop. An example of this spray is a mixture of turpentine and lime, which is sprayed on vegetables to drive away cucumber beetle.

Sprayers.—There are numerous types of apparatus for spraying. A good type for the garden or home use is called the *knapsack sprayer*. This apparatus may be strapped on the back and is very convenient to use. The common type of sprayer used in the orchard is the *power sprayer* which is a sprayer attached to a gasoline engine.

Life, History, and Control.—If a boy expected to have a fight after school he would naturally wish to know something about the other boy. He would ask



Courtesy of the International Harvester Co.

FIG. 64. LIFE CYCLE OF A FLY

himself such questions as: Where will he be? When will he be there? How will he fight? What will he have in his pockets? How big is he? If boys and girls wish to fight insects they need to know something about their habits and life history. The story of the

codling moth is given as an illustration of what you should know about an insect.

The eggs hatch and the worm enters the apple after the blossoms fall, when the blossom end of the apple is closing, and this is the time when it should be killed. If the spraying is delayed for many days, the little worm is hidden safely away in the center of the apple. It is necessary in this case to know also that there is likely to be a second brood or generation within a few weeks. If the larvae or white worms escape death, they will feed upon the apple for about two weeks until they are grown, and then go to the ground to rest for about the same length of time before coming out as full-grown moths. These moths or adults lay eggs for another generation.

Another illustration is the cutworm. This worm lives during the winter in the soil and comes out looking for food early in the spring. As summer approaches, it goes back into the soil and rarely goes deeper than an inch from the surface. Since it is beneath the soil, most of the time it is safe from any spray that could be used. It does not climb upon the plant and eat the leaves, but cuts the stem off near the ground.

The most effective method of avoiding the ravages of the cutworm is to place a tin can, with the bottom cut out, over the plant to be protected. Mr. Cutworm comes along and runs against this tin can. Finding that he can make no impression upon this hard surface,

he proceeds to move around the plant, leaving it alone. If this simple fact were known to boys and girls, much time, labor, and expense could be saved in protecting plants from cutworms.

Other illustrations may be given by the class to show the necessity of knowing the life history in order to fight a certain insect.

Some sprays commonly used are listed below:

Bordeaux mixture, for fungous diseases.

Lime sulphur mixture, for scale insects and diseases of apples and peaches.

Lead arsenate (1 lb. to 50 gal. water), a poisonous spray used for chewing insects such as the currant worm.

Hellebore (1 lb. to 50 gal. water), effective when used on cabbage and other garden plants for chewing insects. Must be used while fresh.

Paris green (½ lb. with 2 lb. lime in 50 gal. water), a poisonous spray for chewing insects.

Write to your state experiment station for bulletins giving the spray calendar for your state.

Problems and Review Exercises

1. Give examples of damage done by insects in your community.
2. What enemies of insects have you seen?
3. What may be done on the farm to destroy the homes or hiding places of insects?
4. Tell how to destroy the Colorado potato beetle.
5. How does plowing in the fall affect insects?
6. What two general kinds of sprays are used?

7. Why is a knowledge of the life history of an insect important?

8. Name the poisons usually used to kill insects.

9. Determine the cost of spraying an acre of potatoes as many times as is necessary to keep the beetle from doing damage. Compare the production with an acre or a part of an acre that was not sprayed. Did the spraying pay?

10. Tell what you would do to combat the cabbage worm.

11. Each member of the class should clip pictures of the various types of sprayers from catalogues, farm journals, and other advertising material. Bring the clippings to school and make up a picture notebook on sprayers. What kinds are best adapted to your community?

12. Name some of the chewing insects commonly found in your community. How would you spray in order to combat them?

13. Make up a spray calendar for your home garden, indicating the kinds of sprays which are used and the time when they are used.

14. Where have you seen sucking insects at work? Can you suggest differences between sucking insects and chewing insects other than the difference in the way they eat?

15. It has been estimated that apple scab alone caused $6,000,000 damage in one year. How many bushels of apples could be purchased at the present price for this amount of money? How many schoolhouses such as yours could be erected for this amount?

16. If spraying an orchard three times per year increased the yield of apples 110 bushels per acre, what is the value, at current prices, of the increase? If the cost of spraying was $40 per acre, what per cent of profit was gained on the investment in spraying?

XVII

INSECTS OF THE GARDEN

Home Work

The following directions are given for home work so that the pupil may know how to combat the various insects. If any insect is not to be found the treatment need not be given.

The Cutworm.—When the cabbage and tomato plants are set in the garden, protect them with old tin cans by cutting out both top and bottom of the cans, placing them over the plants and pressing them down into the soil about two inches. This prevents the worm from reaching the stem of the plant because the worm does not go very deep into the soil, but works just beneath the surface. Heavy paper wrapped about the plant when it is set will serve the same purpose. Cut worms may be poisoned by making a bait of one tablespoonful of Paris green and one quart of bran, mixed with sweetened water, and spreading it near the plants.

The Cabbage Worm.—The cabbage butterfly deposits her eggs on the under side of the cabbage leaf. The worms which hatch from these eggs are very injurious, since they destroy the leaves. Dusting the cabbage

leaves with lime or ashes may prevent the eggs from hatching, but be sure to dust the under side of the leaves.

Spray the plants with a solution of Paris green, using the formula suggested in the chapter on sprays. When the cabbage begins to head, white hellebore should be used instead of the Paris green, as it is less poisonous and not so dangerous to use on a plant which is to be eaten.

Put some of the worms in a jar, keeping some moisture and fresh cabbage leaves in the jar, and observe the development of the worm and the change into the resting stage. Try to catch the butterfly in the act of emerging from the pupa or resting stage.

Cucumber Beetle.—The striped cucumber beetle is a familiar enemy in the cucumber or melon patch. The beetles feed on stems and leaves, remaining on the under side of the leaves. Mix five tablespoonfuls of turpentine with a gallon of air-slaked lime. Dust this mixture on the vines as soon as they come up, repeating the process every few days until the vines are a month old, and the beetles should not cause much damage. Some gardeners spray the plants with Bordeaux mixture and Paris green, which is not only offensive to the insects, but is poisonous to the beetles which eat the leaves.

Colorado Potato Beetle.—Mix Paris green with Bordeaux mixture by putting one-half pound of the substance in fifty gallons of Bordeaux mixture. Spray the potato vines when they are about six inches high, repeating as often as is necessary to keep the beetle in

check. The Bordeaux mixture serves as a repellent to the flea beetle and as a fungicide to check the blight of potatoes, while the Paris green poisons the potato beetle. If the beetles get a start and the spray does not check them, the little red larvae and the striped adults should be "picked" by knocking them into a pan with a small wooden paddle.

Melon Lice.—Spray the melons or cucumbers where the tiny lice are found with a mixture of nicotine sulfate, "Black Leaf 40," which may be secured at a drug store. Be sure to spray the under surfaces of the leaves, as the lice work there. This spray is effective for other plant lice and should be used when the lice appear on the plants. Observe the lady bug or lady beetle as it attacks these lice. If the lice do not get started in large numbers, the lady bug will hold them in check.

Tomato Worms.—Watch for the large green worms to appear on the tomato plants, and pick them off and destroy them. Try to collect some of the worms and observe them go into the pupa stage. Place them in a jar with some twigs and feed them green leaves. What difficulties do you find in growing these worms?

Facts to be Studied

In order to fight insects effectively, we must know their habits. The following paragraphs tell the life story of the insects you have been watching for in the garden.

Cutworms.—There are many different kinds of cutworms, but all of them have similar habits. The cutworm is the larva or worm stage of a grayish-brown moth which flies at night among the trees and shrubs, where it deposits its eggs. These eggs hatch and the little worms make their way to the ground where they begin life among the grasses and clovers, feeding upon the tender plants. By autumn, when the frost comes, the cutworms are about half grown and they must seek shelter from the winter weather, so they find cavities in some fence post, or burrow in the soil.

When the warm days come in the spring, the cutworm comes from its hiding place, a half-grown, hungry fellow, ready to devour any green food. He works just beneath the soil most of the time, doing most of his feeding at night. He eats his way through the stem of tender tomato or cabbage plants, cutting off the plant as he does so. Instead of making the remainder of his meal from the plant which he has just cut down, he goes to another plant, treating it as he did the first one. The worm becomes full grown in early summer and goes into the soil for a resting period of about a month, then comes out as a full grown adult or moth. About two years pass from the time the egg hatches until the worm develops into a full grown moth.

Cabbage Worm.—The green cabbage worm which destroys so much cabbage in the garden during the summer is the larva of a white butterfly, which is

very common in the garden. The female has two black spots on each front wing. In spring and early summer the butterflies deposit their eggs upon the under side of the cabbage leaves, where they may be found in clusters. They hatch into tiny worms, which soon develop into full grown worms about an inch and a half in length. After about two weeks in the worm stage, they go into the resting stage, in which stage they may be found attached to fences or beneath rubbish in the garden. In about ten days the insect emerges as a fully developed butterfly which again lays eggs and the same life cycle is repeated, several generations being produced each year.

Striped Cucumber Beetle.—The yellow and black beetle, which comes in great armies to the melon patch, is familiar to any boy or girl who has tried to raise melons or cucumbers. The beetles feed upon the plants, soon destroying the leaves. The female beetles lay their eggs in the soil near the roots of the plants, and the tiny white worms which hatch feed upon the roots of the plant. The worms remain in the soil during the resting stage, and reach maturity about six or eight weeks after the eggs are laid. The adult beetle hibernates during the winter ready to come out in the spring to devour the young plants. It is interesting to see the large numbers which seem to spring up over night. If one does not keep careful watch over the young plants, the beetles are likely to destroy them before the gardener can destroy the beetles.

The Colorado Potato Beetle.—As soon as the potato plants appear in the spring, a few brown-striped beetles, about one quarter of an inch long, may be seen on the leaves. These beetles deposit yellow eggs in clusters on the leaves. These eggs soon hatch into tiny red larvae which have a wormlike appearance, feeding upon the potato plants, destroying the leaves and stems. After a few weeks, the little red grubs go to the surface of the soil, where they pupate or go into the resting stage, and in ten days or two weeks they come out as adult beetles. Two or more generations grow each year. This beetle is one of the most harmful insects, since it can in a short time check the growth of the potato crop. It begins its damage early in the life of the plant and soon injures the foliage to such an extent that the plant ceases to grow.

Plant Lice.—Most interesting of all is the story of the tiny plant lice and their habits. These insects suck their food from the foliage by thrusting their beaks into the tender tissue. Plant lice may be found on sweet pea vines, house plants, melon leaves, apple sprouts, and on many other common plants.

The first generations produce live young and do not lay eggs, but increase their number very rapidly. The last generation of the year usually lays eggs for the next brood. Sometimes the eggs are cared for by ants and hatch out in the spring. The ants then care for the young lice and help them to get established on some plant. The ant sucks a milky fluid from the lice,

and for this reason plant lice are sometimes called the ants' cows. Some lice have wings and some are wingless, the last brood generally having wings. The lady bug is an enemy of plant lice.

From what has been said of the life story of a few insects, boys and girls can make observations of other insects and become acquainted with their life habits.

Problems and Review Exercises

1. What is meant by "life history"?
2. What are the stages in a complete life history, such as that of the potato beetle?
3. What is the difference in the coloring of the male and female cabbage butterfly?
4. Tell about other injurious insects to be found in the community.
5. What birds have you noticed eating insects?
6. Do you know of any animals that eat insects?
7. Why do insects cause more damage in the worm stage than in the adult stage?
8. Observe the toad to find out how it eats and what it eats. Catch a toad and place it in a box with some green moist turf in it. Catch some flies and other insects and put them in the box.
9. What damage to your garden was done by insects during the past year?

XVIII

THE HONEYBEE

Home Work

Bees at Home.—Observe a hive of bees closely to determine the answer to this question: How early in the morning do bees begin work? Notice the blossoms early in the morning to find the early workers. At what time of day do you find bees in large numbers on the outside of the hive? Can you suggest a reason for the bees' settling outside at this time? How late in the afternoon or evening do you find bees entering the hive?

Bees at Work.—Observe the bees at work. What flowers seem to be favorites with the bees? Time the busy little worker as he sucks away at a flower. What is the longest time spent on any one flower? Does the bee go from flower to flower or does he fly back to the hive as soon as he has finished taking nectar from a single flower? Do the bees go to the most fragrant flowers first? Do you find more bees on the highly colored flowers than you find on such flowers as the tiny white blossoms of weeds or small fruits?

Try to find some drones among the bees and compare them with the workers. Sometimes some bee-

keeper in the locality has an observation hive; that is, one with glass sides. If such a hive can be arranged so that the class can see the bees at work in the hive a most interesting study may be made of their habits within their home. The teacher may be able to secure such a hive for the school. Place some bottle corks in a pail of water and set it near the hive of bees. Do the bees seem to enjoy the water? Your answer to this question will depend upon the time of year. Try it in early spring, in summer, and in the fall.

Write a story telling what you saw as you watched the bees at work.

Facts to be Studied

Lessons from the Bee.—Boys and girls may learn many valuable lessons from the close observation of a family of bees. Let us look into the home and see how they live in the little rooms which they build and which we call cells. Every cell or room is neatly and carefully made. So well are they made that we cannot tell one room from another as we look at the comb. The bees seem to take pride in their home and they do many things to keep it in perfect order.

Only the best of the nectar is good enough for the honeybees for they will seek out the sweetest flowers from which to gather honey rather than take sugar which has been placed within their reach. This honey is carefully stored in the cells or storerooms and thus provision is made for the winter food supply. What

in nature is more wonderful than the pound of honey so neatly and carefully packed in cells and sealed so not a drop can escape? It is the result of untiring industry and foresight on the part of the little bees. Let us remember that these little friends are really not preparing these packages of delicious honey for our use, but for their own family use, and when we take the honey from the hive we are robbing the bees of the food which they have stored for their own use.

The Family.—Let us inquire about the family which seems to dwell in such complete harmony within the home. There is always one mother bee called the queen bee, and she has more children than the "old woman who lived in a shoe." As in some families, there are certain members that do the work while others are idle. In the beehive are many hundreds that do no work. These are called drones.

The Queen.—The mother bee is really and truly a mother in the hive for she lays the eggs which later hatch into workers and drones. When the bees find themselves without a queen, disorder is likely to result until another queen is reared. The queen bees are hatched from eggs which would ordinarily develop into workers, the difference being that the eggs are placed in larger cells called queen cells. The young are fed on "royal jelly," a special food which causes the newly hatched bees to develop rapidly and to a larger size than ordinary bees. When several hatch and develop, all are killed but the one that is strongest, and this one

grows into the queen bee. The queen stays in the hive except when the bees swarm and then she takes what is called her bridal trip. This happens when she is about a week old. On this bridal trip the queen bee mates with a drone while flying in the air. Her eggs may thus be fertilized and she goes back to her hive to lay several thousand eggs in the cells of the comb.

The Workers.—The workers are the female bees that gather the honey, build the comb, and take care of the home. It is the workers that sting, fight the enemies of the family, and gather food for the young bees. In size the workers are the smallest bees of the group. They are hatched from the fertilized eggs which the queen lays in the cells of the comb. The workers do not usually lay any eggs, though sometimes they do lay a few which may hatch into drones. Workers live but a short time; those reared in summer do not live much longer than a month because of the strenuous work they do, but the winter workers may live six months because they have less work. The family or colony of bees must be kept up in numbers by the queen, and she is able to do this by laying large numbers of eggs—two or three thousand in one day.

The Drones.—The lazy bees that do no work about the home are males and are hatched from unfertilized eggs deposited by the queen. The only purpose of the drone is to mate with the queen. Only one drone mates with a queen, so there are always hundreds of drones and sometimes thousands in a hive that are of

no value to the family. They are killed by the females or workers, sometimes being killed in the hive and carried or dragged outside. The killing of drones takes place soon after the bees swarm. The drones are somewhat larger than the females and may be distinguished as they fly through the air by a louder buzz.

The Bee's Life Story.—The changes which take place in the body of an insect have already been described and how truly wonderful they are. The bee is an insect belonging to the order of Hymenoptera, meaning that it has membrane-like wings. The eggs are deposited in the cells of the comb in the part of the hive set apart for hatching purposes and hatch in about three days into tiny white worms or larvae. These little worms do not crawl out and hunt food for themselves as do the cabbage worms and cutworms. So the workers feed the tiny creatures a substance they produce, which may be said to correspond to the milk which the cow feeds her young. After a few days they are fed honey and pollen from flowers and the tiny white worms grow very rapidly, reaching maturity in about a week. The cell is then sealed by the workers and the worm or larva goes into the resting stage by spinning a cocoon about its body, and after a few days it changes into the adult form. The workers develop into full grown adults in three weeks' time after the egg is laid, while the drone requires a few days longer. The workers soon leave the hive and go to work for the family.

What Is Beeswax?—It is indeed a remarkable and interesting fact that bees are able to make the comb and arrange the cells in such perfect order. The wax which makes up the comb is made by a peculiar process of digestion and appears in scales on the under side of the body of the bee. It requires about twenty-four hours to make these scales. The bee goes out and fills its stomach with honey or nectar from the flowers, then remains quiet for twenty-four hours while these scales form; it then uses the waxy scales to make up new cells in which to store more honey.

Nectar or Honey.—Bees are said to make honey from the nectar or sweet juice of the flowers. However, they really do not make honey, but gather it; for the honey is really just the nectar of the flowers after a large part of the water has evaporated. The bee gathers the nectar by sucking it into her stomach and when she has a load she goes to the hive and deposits it in the little cells already made. If no cells are vacant, she waits until the honey is changed into the waxy scales and then makes more cells before going out after more honey. The cells are not sealed until the honey cures or ripens, which means that the water has evaporated from it. How strange and interesting it is to know that the bee does all this and yet makes a neat package without a trace of the sticky substance on the outside of the cap which seals the tiny cells of honey.

Flowers for Honey.—Bees gather honey from many different kinds of blossoms, the honey locust being a

common tree which furnishes good honey. Perhaps the most common honey plant found on the prairies is white clover. The blossoms of sweet clover also furnish a very excellent quality of white clear honey. Buckwheat, which is often planted for the benefit of bees, yields a darker honey than does clover. Many common weeds produce honey. The flavor and color of honey depend upon the kind of plant from which it was taken. Farmers who have bees should provide some flowering crops throughout the season for them, and should not expect a good quality or quantity of honey in the fall if the bees have been starved through the summer season.

The Bee Sting.—Many boys and girls are not very friendly with the honeybee, in spite of all its good traits and interesting habits, because they are afraid of the sting. The idea that bees are not friendly has developed from experiences with wild and poor grades of bees. The Italian bees are not so wild and ferocious as the ordinary bees. Queen bees may be purchased from firms handling bees and in this way the colony may be improved. The bee has a sack of poison connected with the sting, and some of this poison may be sent into the blood when a bee stings an individual. Some people are affected very little, while others suffer greatly from stings. There is little need for alarm if the bees are treated well and handled properly, but for safety, bee-keepers use a net covering over the face and a bee-smoker when robbing the hives or handling the bees.

Problems and Review Exercises

1. Describe the different kinds of bees to be found in a hive or colony.
2. How does the queen bee differ in regard to her daily habits from the other bees?
3. Which bees lay eggs?
4. Where are the eggs deposited?
5. Describe the life changes which take place as the bee develops or grows from the egg to the adult bee.
6. How does honey from the hive differ from the nectar which is in the flower?
7. What different colors have you noticed in honey? How many different flavors have you tasted? Which kind of honey do you like best? Why?
8. How many farmers in the community keep bees? Do they regard it as a profitable side line on the farm?
9. What do you do in order to relieve the pain when you are stung by a bee?
10. Write a short composition on the subject of "How Bees Make Honey."

XIX

MACHINES

Home Work

Make a survey of your home farm to determine the kind, amount, and value of the farm machinery. Tabulate as follows:

Implement	Age	Condition	Original Cost	Estimated Present Value

How much depreciation should be allowed each year for the wear and tear of machinery? This can be estimated by dividing the cost of the machine by the number of years it lasts.

Find a strong bar or pole ten feet long. Test your ability to lift weights by means of this lever. Place a block one foot from the end and use the bar as a pry bar or lever. How much can you lift? Place the block two feet from the end. How much can you lift? Make other tests of your strength and the advantage afforded by the lever. Study the block and tackle if

you have one on the farm. Make one from spools and cord.

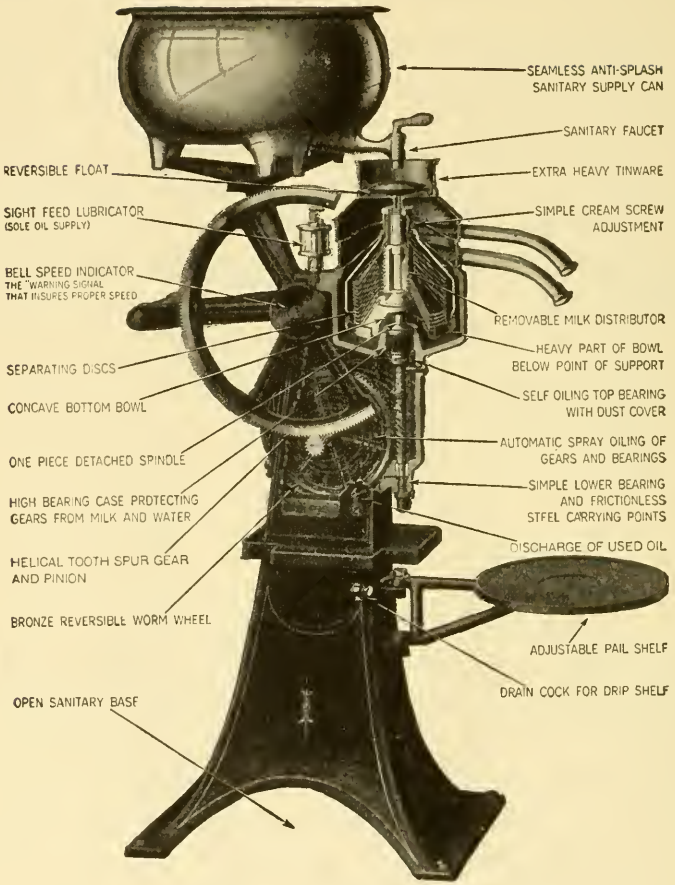
Study the plows used on your farm. What types of moldboard do you find? What width of furrow does the plow make? How many horses are required to draw the sulky plow? How many acres can one man plow in a day with a two-horse walking plow?

Study a farm wagon. Ask your father to help you name the parts. List all the parts of the wagon as follows:

Parts	Number	Purpose

Facts to be Studied

Machines an Aid to the Farmer.—The machine enables man to do much that could not be accomplished without its use. One man can lift a heavy stone to the top of a high building with the aid of a pulley; he can turn the sod of several acres of land a day by means of a tractor; he can go long distances in a short time by using the automobile. Suppose the stone could be lifted only by hand power, the sod had to be turned without the aid of a plow or even a hoe, and the trip from St. Louis to Chicago could



Courtesy of De Laval Cream Separator Co.

FIG. 65. A MOST USEFUL MACHINE ON THE FARM IS THE CREAM SEPARATOR WHICH ENABLES THE FARMER TO SELL CREAM AND SAVE THE SKIMMED MILK FOR FEED.

be made only on foot. What a slow kind of life we should experience. Remember that most of the modern machines have come into general use only lately. Find the dates when the various farm machines were invented.

The basic principles of the machine have been known for centuries. While man has not always had the advantage of the modern reaper and the modern engine, yet he has, in some measure, taken advantage of the principles involved in the make-up of these machines. The first implement which can be said to have been a plow was the flint rock tied to a stick and used by the Indians. To be sure it did not look much like our modern plow but the principle was the same.

Classes of Farm Implements.—Farm implements may be grouped under various headings according to their use on the farm. The following classes should be studied: tillage machinery, seeding machines, cultivating machines, fertilizing machines, harvesting machines, cutters and threshers, stationary equipment, and tools.

The Plow.—The main implement belonging to the first class is the plow. There are two general classes of plows, the moldboard and the disk, the moldboard type being the more common of the two. The disk plow is used in deep tilling where a double plow is needed. There are several types of moldboards ranging from the straight sod moldboard to the short-curve stubble moldboard. Pupils should report on the plows used on the various farms in the district. It is

very likely that the boys have never noticed any differences in the shapes of the plows.

Land tillage in America probably began when the Indians used the wooden hoe or the flint hoe which was followed by the wooden plow with a wooden moldboard.

The gang plow is a double plow and is built as a riding plow. The modern tractor plows sometimes have as many as twelve plows working at once, all drawn by one engine. In large fields the tractor does excellent work and is a good investment.

The Harrow.—The purpose of the plow is to break the soil so that it can be more thoroughly prepared for the seed bed; but the harrow is the principal implement used in the preparation of the soil and its use is especially necessary in preparing a good mulch on the newly plowed ground in order to retain the moisture. The harrow need not be used immediately after fall plowing, but when corn ground is being prepared in the spring the harrow should be used as soon as the ground is broken. There are various kinds of harrows, the most common being the spiked-tooth harrow. The disk harrow is frequently called a disk. It is composed of a series of disks and pulverizes the soil more efficiently and to greater depth than the tooth harrow. There is a harrow called the spring-tooth which is not so common as the other two.

The Roller.—The roller is used for the purpose of packing the soil after it has been harrowed or in some

cases after it has been planted. It is very simple in construction. Sometimes it is made by putting an axle in each end of a cylindrical log and fixing a double-tree and tongue.

Types of Cultivators.—There is not space here to say something about each class of farm machine, but some attention should be given to the different types of cultivators. There are three main types of corn cultivators: the disk, the shovel, and the surface cultivator. The relative merits of these types are disputed by farmers and in some communities one kind will be found while in another the other types will prevail. There are certain outstanding features and advantages of each type that should be recognized. The disk cultivator can be used while the corn is yet very small to stir the ground thoroughly. It leaves the soil in good condition. The shovel cultivators stir the soil to greater depths and can be used successfully where this is necessary. The surface cultivator should be used where only a top mulch is needed. It is the best type for the later plowing of corn as all weeds can be cut by the surface cultivator and a mulch can be produced that will hold the moisture. At the same time, the soil is left in good condition and the surface can be made level. The condition of the soil, the weeds, the season, and the stage of the growth of the corn are all factors which must be considered in choosing a cultivator. Whatever kind is used should be so operated that it will leave a fine mulch of soil and

destroy all weeds. Good cultivation depends largely upon correct adjustment of the cultivator rather than upon the type of the cultivator used. The writer has seen a field of corn almost ruined because the cultivator was not properly adjusted the first time the corn was plowed. Sometimes the harrow is used as the cultivator, corn being frequently cultivated for the first time by the harrow. Wheat is sometimes harrowed and alfalfa is frequently disked or harrowed after the first cutting in the spring. Many types of garden cultivators have been devised.

Care of Machinery.—Some farmers allow their machines to remain out in the open weather all winter. Others build substantial sheds for the housing of their machinery just as they build barns for their cattle. Pupils should find the cost of constructing a machine shed large enough to shelter the machinery of the average farm. Will it pay to house the machinery?

It is not an uncommon sight to see plows and even binders standing out in the field all winter long. All iron is subject to decomposition or rusting when the moisture and air come in contact with it. Plows should be painted in the fall with a heavy oil or grease to keep the moisture and air from rusting them. If they are put under shelter and painted they will be as bright in the spring as they were in the fall; but if allowed to rust all through the winter, they will be unfit for use in the spring. Much time will be consumed in ridding the moldboard of the rust in order to make it turn the soil.

Make a survey of the tool sheds of your own homes. How many bright saws, hammers, bits, squares, and planes are found? How many neatly kept tool chests do you find? Are the tools arranged in an orderly way in the tool shed? Do you know where to find certain tools when they are needed? Is the spade in its place? Will it cut the sod when necessary or is it dull and rusty? These are some of the suggestive questions which every boy and girl may ask about his or her home. Would it not be interesting to write a story giving a description of the tool shed at home? Boys and girls may be of much service in helping to conserve the wealth of the nation by taking care of the tool sheds at home.

A good old man more than seventy-five years of age came out into the field to do some work one morning. He had an object under his arm which was wrapped securely in an old newspaper. We wondered what it could be. When he was ready to go to work, the boys saw him carefully take the paper from this object and fold the paper for further use. He showed us a clean, bright, well-oiled, and well-preserved spade. For more than thirty years he had used this spade but it had never been allowed to rust. It had never been put away in a hurry with the wet soil clinging to it. The man had found it to his advantage to have the spade always ready and when he was through using it he cleaned it before he left the field and again wrapped it in paper, for he had to ride on a train to get home.

There is a lesson in this incident for every boy and girl who is in the habit of using tools and leaving them in the most convenient place without cleaning them. It pays to take care of machinery just as it pays to take care of the animals on the farm. The tools do not need food but they will respond as quickly as living beings to good care. Good care tells in the life of the person. It will tell in the bank account of the farmer.

Review Exercises and Problems

1. What is the total value of machinery on all farms studied by the class?

2. Are there fewer horses in your community than there were five years ago?

3. Give illustrations of the inclined plane and of the lever.

4. Give five reasons for building a machine shed.

5. How many board feet of lumber are required to make the sides of a machine shed forty feet long, twenty feet wide, and twelve feet high if the siding is made of plain one-inch boards? What would it cost?

6. Write a story telling what you saw in your tool shed when you opened the door.

7. What advantages do tractors have over horses? What disadvantages?

8. What kinds of cultivators are used in your community? Why is this kind preferred to other kinds?

9. Secure catalogues giving prices of machinery and make a list of machinery needed on your farm with the cost price of each if it were purchased at the present time. What would be the cost of the necessary machinery for the farm?

XX

A STUDY OF THE GAS ENGINE

Home Work

How many farmers in your community own gas engines? Make a list of all the farm operations for which the gas engine is used. What kinds of engines are used on the farms in your community? Tabulate the results as follows:

STATIONARY ENGINES

Total Number in Community	Number of Cylinders	Name of Make	Horse Power	Cost

Make a similar list of the tractors and automobiles.

Study a stationary engine to locate the following parts: cylinder, piston, spark plug, crank shaft, connecting rods, valves, push rods, flywheel. If possible, have some one help you take the engine apart. Answer the following questions about your engine or the engine of your neighbor:

1. How many cylinders has it? What is the diameter of each? If you cannot take the cylinder head off to examine the parts, obtain a catalogue showing a photograph of an engine and its parts.
2. How many piston rings on each piston?
3. What kind of spark plugs, if any, do you use?
4. What is the diameter of the flywheel?
5. How many revolutions per minute should the flywheel make when running at ordinary speed?
6. What kind of fuel is used?
7. How much fuel is required per hour when the engine is doing heavy work?

Facts to be Studied

The gas engine is rapidly becoming a universally used machine. In many sections of the country it is taking, in the form of tractors, the place of horses on the farm. A very large percentage of farmers use the gas engine for some purpose though they may not own a tractor or an automobile, both of which depend upon the gas engine as the source of power.

The name gas engine is commonly applied to any engine which obtains its power by internal combustion; that is, by exploding gases within itself. The gas which is exploded or burned is called the engine's fuel.

The uses to which a gas engine may be put on the farm are so numerous and varied that a complete list would be too long to be included in this lesson.

The tractor and automobile are the two principal machines which depend upon the gas engine for power. The stationary engine may be used for such purposes

as operating the pump, the feed grinder, the wood saw, the cream separator, the washer, the churn, and other devices which can be operated by the pulley. The tractor has been adapted to a great many different operations, from mowing lawns to threshing grain. Many kinds of machines have been adapted to its use.

In order to obtain energy or power from the horse or other animal, some kind of feed is necessary. In order to obtain power from the gas engine, feed or fuel is necessary. Gasoline is used almost exclusively in automobile engines. The tractor is operated, as a rule, by the use of a heavier fuel than gasoline, usually kerosene. Whatever fuel is used must be of a kind that is easily evaporated and must be inflammable when mixed with air. Kerosene is much cheaper than gasoline, hence its use is common in engines which are adapted to its use.

Every boy on the farm is familiar with the intense heat of the fire box of a steam engine at threshing time. It is necessary to change the water into steam by intense heat. In the gas engine the fuel, whatever it be, is changed to gas by evaporation. For this reason the engine must be hot in order to get the best results; not hot enough, however, to boil the water in the cooling tank. The gas enters a chamber called the cylinder and is exploded by an electric spark from the spark plug. When gas explodes it expands. Intense heat is created by the explosion. The expan-

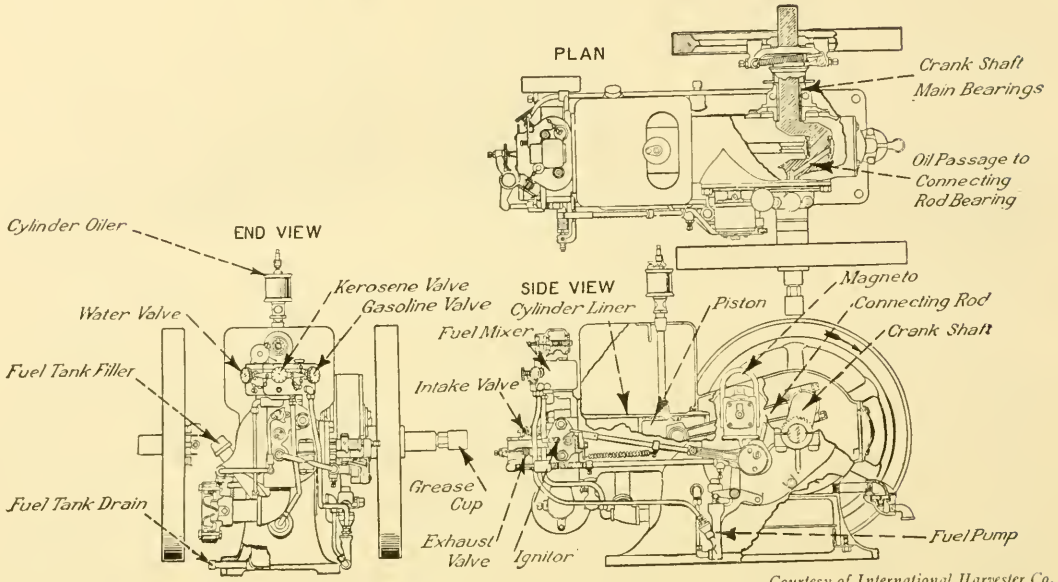


FIG. 66. DRAWING SHOWING THREE VIEWS OF A GAS ENGINE WITH MOST IMPORTANT PARTS LABELED

sion caused by the explosion causes the piston to move, which, in turn, turns the crank shaft. The illustration shows these different parts and their relation to each other. It is this burning of gas that is called internal combustion.

Some Parts of the Gas Engine.—The *cylinder* is the chamber in which the explosion of gas takes place, the piston moving up and down in the cylinder. The walls of the cylinder are perfectly smooth so as to prevent unnecessary friction and to allow the piston to fit closely in the cylinder chamber.

The *piston* is fitted with one or more rings which fit in grooves about it like a spring. The rings are cut in one place and are always springing or pressing outward against the cylinder wall, thus making it impossible for the gas or oil to escape along the sides of the pistons.

The *spark plug* is a small piece of apparatus, but it is most important. Nearly everyone is familiar with the peculiar "chug chug" of the automobile or tractor when it is "missing," a trouble which is due in all probability to the spark plug. The spark plug is the match which ignites or fires the gas in the cylinder. An electric current passing through the plug jumps from one point to the other, causing a spark. One can see this spark by placing the metallic part of a screwdriver on the engine and bringing it close to the plug while the engine is working, causing the spark to jump from the plug to the screwdriver. If the spark plug

becomes dirty or is broken, the spark is either not formed or is not "alive" and does not fire the gas. In this case there is a loss of power and the engine is said to "miss." The engine must be timed so that the spark fires the gas at the instant when the piston is in proper position. Sometimes, for various reasons, spark plugs get very hot and the porcelain part is then likely to break.

The *crank shaft* is a shaft to which the pistons are connected by rods. The shaft really has one or more cranks on it to which the rods are fastened. As the pistons move up and down, the shaft is forced to turn, changing the up-and-down motion of the pistons to a rotary motion of the crank shaft, thus turning a fly-wheel. This change in motion is similar to the change in motion which takes place when the pedals on a child's velocipede are pushed back and forth. This causes the shaft to turn, and the shaft causes the wheels to turn. The connecting rod is fastened to the piston by a piston pin. The rod moves to and fro as the hand moves at the wrist, which gives this pin the name of the "wrist pin."

Cylinders and pistons get very hot as the latter move back and forth in the former and must be cooled continually or the cylinder walls would become overheated in a short time. A jacket called a *water jacket* is placed around each cylinder and water circulates through these jackets to cool the walls. In the winter, when the engine is not in action, this water

must be drained off or it will freeze and burst the jacket walls.

There must be an entrance through which gas may get into the cylinder and an opening for the burned gases to escape. These openings are closed by means of *valves*. The valve consists of a piece of metal which is ground to fit the opening exactly. These valves are so connected with the cam shaft that they open and close at the proper time. If a valve becomes worn so that the gases leak out and the power is reduced, it must be ground. When it fits into the openings exactly it is said to "seat." The valves are usually connected with the shaft by means of long push rods. When the shaft turns, it moves the push rods up and down, thus opening the valves. The valves close by means of strong springs which force them back into position.

It is obvious that the many parts of an engine, working rapidly and becoming heated, must have plenty of oil or the parts would soon be ruined by the friction. The crank shaft is in a large iron case called the *crank case* which should always contain oil. The revolving shaft picks up the oil and splashes it over the parts. An oil pump is constantly pumping the oil to all parts of the engine. If the oil becomes low, the pistons heat and stick in the cylinders, causing the engine to stop running.

A *flywheel* is attached to the shaft or axle and thus power is given to a belt which runs on a pulley attached to the flywheel.

If one part of an engine can be said to be more important than another, that part is undoubtedly the *carburetor*, which is of very intricate construction and may cause much engine trouble. It is the part in which the air and gas are mixed and taken into the cylinders and might well be called the "mixer." Every boy knows that the coal and wood in the stove will not burn satisfactorily unless they get air which is admitted to the fire box through the openings in the stove called draughts. The air is mixed with the gas in the mixer or carburetor and the gas explodes readily when the spark ignites it in the cylinder. There are many types or makes of carburetors, but the principle is the same. Gas is taken in through the small opening controlled by a valve; air is then admitted to the chamber and the mixture passes on to the cylinder chamber where it is fired or exploded by the spark of electricity.

The gasoline or engine fuel goes into the mixing chamber through a needle-sized opening and really sprays into the chamber. The fact that it sprays into the chamber causes it to mix with the air and the heat of the running engine causes rapid evaporation, or change to gaseous vapor, just as heat causes water to evaporate and form steam. Carburetor trouble is not easy to remedy and it is best not to meddle with the carburetor. If it is causing difficulty, have an expert mechanic adjust it.

Lubrication.—Lubrication means oiling. The purpose of oiling is to prevent wear. When the machinery

Courtesy of the Avery Plow Co.

FIG. 67. PLOWING WITH A TRACTOR

is not well oiled, the metal surfaces come together and wear very rapidly. Many repair bills may be saved by using a proper amount of oil. The parts which do most work and bear the greatest strain need most oil. A few minutes of wear without oil will cause more damage than weeks of wear with plenty of oil present. There are two general types of oil: hard oil or cup grease, and ordinary liquid oil. The hard oil is placed in cups which are screwed into an opening leading to a part which needs oil. As the grease is used up the cup is screwed in. There are usually drip cups on all stationary engines from which oil drips continually while the engine is in action. These cups should be kept full of a good grade of lubricating oil.

Summary.—There are many other parts with which boys and girls will become familiar as they study the gas engine but the above description tells us about the main construction of the gas engine. It is an efficient machine and develops great power for the use of the farmer and his wife and may be called a self-feeding, self-working power plant. The fuel flows in through the carburetor, is mixed with air in the mixing chamber, from which it is taken into the cylinders. It is there exploded by the electric spark. The expanding gas forces the pistons to move, thus causing the crank shaft to rotate. The shaft distributes the energy or power to the flywheel, which is attached to other machines by means of a belt.

Review Questions

1. Name the parts of the gas engine which you know at sight.
2. Why should the cylinder walls be perfectly smooth?
3. What is the purpose of piston rings?
4. What is the crank shaft?
5. Why should an abundance of lubricating oil be used at all times?
6. Explain the purpose of the carburetor.
7. What might cause spark plug trouble?
8. The pulley on the flywheel of a gas engine is 10″ in diameter. A belt extends from this pulley to a 5″ pulley on a cream separator. Which makes the larger number of revolutions per minute? In what proportion is the speed of the larger to that of the smaller?
9. Explain how you would lower the speed on a pump jack by changing the size of the pulleys.
10. What are the benefits to be gained from the use of a gas engine on your farm?

XXI

THE AUTOMOBILE

Home Work

Make a survey of the community to determine the number and kinds of automobiles owned by the farmers. Tabulate the results as follows:

Make of Car	Number of Cylinders	Color	List Price	Model or Year	H.P.

Study your car at home, locating the parts discussed in the following pages. Obtain an illustrated catalogue showing the parts of your car and make clippings of the illustrations which show the parts to be studied.

If you do not have a car at home, spend some time with some one in the class who has one. Perhaps a farmer will be willing to stop at the schoolhouse and explain the parts to the class. Ask the owner of an automobile to help you answer the following questions:

1. Does the motor run at higher speed when the gear is in low or when it is in high?

2. What is the purpose of putting the gear in low to start the car?

3. What mileage is obtained from the various makes of tires commonly used in your locality?

4. What is the difference between cord tires and fabric tires? Which cost more?

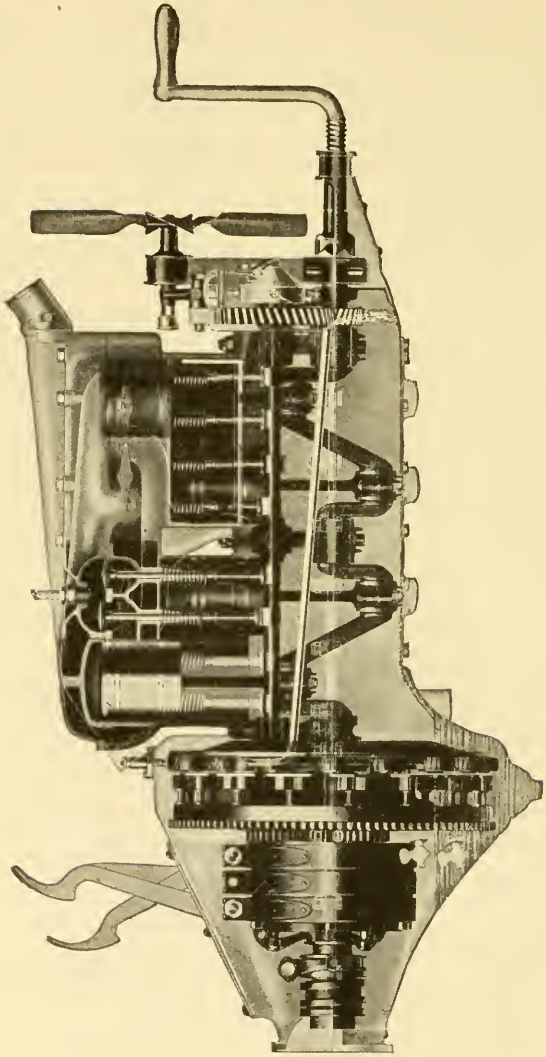
5. Why is loose sand dangerous as a roadbed for automobiles?

6. What is the highest speed record on a speedway? Who holds this record?

Facts to be Studied

Importance.—No business has experienced such rapid growth and development as the automobile industry. The manufacture of automobiles represents a high point in factory possibilities. A large number of automobiles are to be found on the market and new ones are appearing each season. Farmers use this means of travel in all parts of the United States. It is becoming as truly necessary for the farm boy to know how to operate and care for automobiles as it was for the farm boy of earlier years to know how to care for horses and different types of vehicles.

A Self-Propeller.—The lesson on the gas engine taught us some of the elementary principles of the engine. The automobile is a self-propelling vehicle inasmuch as its source of power is an engine, usually a gas engine. While there are many types of engines, the principles are the same in all. In this lesson we shall study the parts of the automobile in the same way that we studied the parts of the gas engine.



Courtesy of the Ford Motor Co.

FIG. 68. THE ENGINE OF A FORD AUTOMOBILE

Chassis and Body.—The word *chassis* means a frame. The chassis (pronounced shȧ′ sē) of the automobile is the frame with the wheels and machinery, the other part being the body. Sometimes the parts of the chassis are made in different factories and put together in another factory by a different manufacturing concern. Bodies were originally made of wood and were rather heavy and cumbersome, but were durable. Most bodies are now made of metallic substances and are much lighter in weight than the wood bodies.

Parts.—The main parts of the stationary engine have been discussed in another lesson but some words which are used to name various parts of the automobile should be learned. The *clutch* is that part by means of which the drive shaft is connected and disconnected with the engine. If the wheels were permanently connected with the engine by means of the drive shaft, the car would necessarily move when the engine was started. To prevent this, there is a break in the shaft which allows the engine to "run idle," that is, to run without moving the car. The clutch then connects the flywheel of the engine to the driving gear, accomplishing the same result that the belt does when it connects the flywheel of the engine to a thresher or other machine.

The *transmission gears* which engage or connect the engine and drive shaft are moved back and forth by a shifting lever. There are usually four different gears, first or low, second, third or high, and reverse, which means that there must be four connecting gears. When

the lever is in "neutral" none of the gears are engaged or connected to the driving shaft and the automobile remains stationary even though the engine is running. The transmission is just beneath the footboard immediately behind the engine in most cars.

The engine or crank shaft must be connected with the wheels in order to move the car. The drive shaft extends to the rear axle where it is attached to the "*differential*" which is a device located in the center of the rear axle to equalize the power applied to each of the rear wheels. It allows one wheel to travel faster than the other when the automobile is rounding a corner or curve.

Much depends upon the rear *axle* or the part to which the wheels are attached. Some axles are called "full-floating" because they float or turn in oil and bear none of the weight of the car, this weight being borne by the housing or casing about the axle. Axles on buggies must be stationary and bear the entire weight of the load. The "full-floating" axle turns the wheels because it is attached to the driving gear and to each wheel. The "part-floating" axle is another type and bears a part of the weight of the car.

Much depends upon the *steering wheel* and the gears which it turns, as every move made by the car is directed by the steering wheel. It should be kept well oiled and properly adjusted at all times.

Everyone who has had experience with a car knows the purpose of a *radiator* and the troubles it causes.

It should be kept full of water at all times when the car is running as the water must circulate through the jackets about the cylinders to keep them from becoming too hot. There is usually a force pump on the engine to cause the water to circulate freely. The water is taken into the jackets from the lower part of the radiator and returns to the radiator through the hose or tube leading into the top part of the radiator, cooling again as it flows downward through the radiator.

Without a cooling system the cylinders would become hot and the pistons would stick when the lubricating oil burned. Overheating of the engine indicates that something is out of order, and the first place to look for a defect is the radiator as the water may be low or circulation may be stopped by some obstruction. The fan which is placed between the radiator and the engine draws the air through the radiator and causes the water to cool quickly. If the fan belt becomes loose or the blades of the fan become bent, the water does not cool readily and the engine heats.

Freezing.—In cold weather, water will freeze in the radiator even when the engine is running. If the temperature is below freezing, an anti-freezing solution should be used, the one most commonly used being a mixture of wood alcohol and water. A mixture of one part of each will not freeze at a temperature above 30° below zero. The alcohol evaporates rapidly when the engine becomes heated, so the radiator should be examined frequently to make sure that plenty of alcohol

remains. The author has found that alcohol evaporates less rapidly if a quart of ordinary cylinder oil is poured into the radiator. When the engine stops, the heavy oil comes to the top and prevents the evaporation of the alcohol. Make sure to prevent freezing, because a radiator which has burst is not only annoying in many ways, but is also likely to cause overheating at a time when the driver is not looking for trouble. Most drivers cover the radiator and the hood with a waterproof blanket during cold weather. This retains the heat and insures better service. However, the radiator should not be completely covered, or the engine will overheat because the solution in the radiator will soon boil. A space in the center of the radiator should be exposed.

The Storage Battery.—The storage battery is the source of much difficulty because so few people understand it. The storage battery consists of cells or jars of chemicals in which electricity is "made." Another means of generating or "making" electricity is by means of a dynamo, magneto, or other type of mechanical generator, and most cars are equipped with such generators. The electricity flows through copper wires attached to the storage battery, to the spark plugs where the current is broken at the points on the plug. It jumps across the gap, causing a spark as it does so. It is this spark that fires the gas or fuel in the cylinder, just as a match fires or kindles the fuel in the stove.

The mechanical generators on the engine cause an electric current to flow into the storehouse or storage battery when the engine is running and the battery is then said to be "on charge." It is really storing up electricity which it can send to the spark plugs to fire the gas.

Care of the Battery.—The battery is an expensive part of the automobile and should receive careful attention as many things may happen to cause it to lose its power. The liquid in the glass jars must be kept above the edges of the plates within the jars by adding only clear rain water or distilled water; that is, water that contains no mineral matter. In cold weather the battery should not be allowed to "run down" as it will freeze. Batteries that are fully charged will not freeze in our coldest temperatures. It is a good plan to have the battery tested and filled every two weeks at the garage or battery station.

Some Common Causes of Car Troubles

When farmers drove horses on the road it was not a frequent occurrence, though one which did happen sometimes, to see a balky horse stand in the road refusing to do the bidding of his master. But since the car has become a common means of travel it is not an uncommon occurrence to see some one "stalled" along the roadside. Many hours of waiting and much hard work might be saved to the autoist if more atten-

tion were given to details, and if each driver studied the make-up of his car. A few of the common difficulties will be discussed here for the purpose of causing boys and girls to observe more closely the operations of the automobile. Often a large repair bill can be avoided by careful observation.

The Engine Will Not Start.—The feeling which a balky car arouses in the driver is a well-known experience, but often the cause of the difficulty may be easily located and remedied. Some causes are as follows:

1. The carburetor is flooded and should be drained of excess gasoline.
2. The supply of gas may be low or entirely used. Many amateur drivers have become overheated from cranking a car on a hot day only to find the gas tank empty.
3. Dirt or other material may be obstructing the opening to the carburetor, permitting only a scant supply of gas. This is frequently true when the engine "spits."
4. The wiring may be disconnected at some point, preventing the spark or fire.
5. The coil and other wiring may be wet from the rain.

The Starter Will Not Turn the Engine.—Sometimes the starter fails to turn the engine. In such a case the battery may be weak and the engine may be started with the hand crank. A long run will probably recharge the battery, but if the car is used for short drives only, the battery should be recharged at the garage. The battery and starter may be in good shape and yet not turn the engine. If the engine cannot be turned

by hand, the trouble is probably in the cylinders. The pistons may be lodged because of overheating. In cold weather it sometimes happens that the engine becomes locked and cannot be turned by hand or starter. The water pump may be frozen in this case, or it is likely that the starter gear or wheel has lodged or frozen to the flywheel. If this is true, shift the gear to third or high speed and push the car backward by hand. This motion will dislodge the starter from the flywheel and the engine may be turned.

Missing.—Missing may be caused by various defects. The sound of the engine that is chugging along on one or two cylinders when it should be using four or six is a familiar one. The explosions are not regularly placed, and the engine "misses" due to the fact that the fuel or gas in one or more cylinders is not fired by the electric spark. One wire leading to the spark plugs may be disconnected or broken or the points of the spark plug may be so far apart that the current cannot jump across. The car should not be driven far while the cylinders are failing to fire. Missing may be due to a dirty or broken spark plug, a weak mixture of gas, overheating of the engine, or other causes. The cause should be located before the car is driven very far.

Knocks.—Knocks in the engine may be due to many different causes, but whatever the cause, it should be corrected. Frequently a motor knocks when it is pulling up hill on high and in such a case the spark should be retarded. The tappets frequently become

loose and cause a clicking sound. Loose bearings cause a knocking sound and should be taken up or the shafts will soon be worn. Carbon deposits in the cylinders are the result of too much oil or the use of a poor grade of oil. This condition causes knocking and is more likely to occur when the pistons are worn, thus allowing oil to get by the pistons in large quantities and be burned in the upper portion of the cylinder.

Tire Trouble.—Perhaps no other difficulty causes the motorist so much annoyance as "tire trouble." Most cars are equipped with pneumatic tires, that is tires that are filled with air, and the tire upkeep is an expensive item in the maintenance of an automobile. There are several preparations on the market at present which take the place of the inner tube and air. The casing is filled with a rubber-like substance which gives the tire about the same hardness or fullness as if it were pumped to seventy-pound pressure. The tire which is filled in this way can be used until it is worn out and there are no punctures and no blow-outs. There are advantages in both methods of filling tires. Some electrics and trucks are equipped with solid rubber tires but the solid tire causes much more rapid depreciation of the car than air-filled tires.

The most common tire trouble is the puncture of the inner tube caused by a thorn, a tack, a wire, a splinter, or other sharp object. The car should be stopped as soon as the tire begins to lose air, otherwise the rim of the wheel will soon cut the tire. Usually

the puncture can be mended with a patch and the tire can be replaced at once.

A blow-out is a more serious difficulty. The outside casing breaks or blows out, leaving a rent in the rubber and fabric as well as in the inner tube. If the tire is an old one, it is usually economy to sell it as junk; but if the tread is not worn much, it may be vulcanized. Tires may be retreaded for about one half of the original cost of the tires. There are different opinions as to the economy of retreading or half-soling the worn tire.

Tire trouble cannot be avoided, but it may be lessened by proper attention. Tires should never be run without sufficient air in them. From 50 to 90 pounds of pressure is to be recommended, depending upon the size of the tire. Remember that tires become very hot in the summer time. Heating increases the pressure of air by expansion and if one were to pump small tires to 70 pounds on a hot summer day and then take a long trip, the increased expansion due to the heat would be likely to cause a blow-out. If the wheels get out of line, the tires will be cut in a few days because they do not run "true."

Review Exercises and Problems

1. In what way can an automobile be said to be self-propelled?
2. What is the meaning of the word "chassis"?
3. What happens when the clutch is "let in"?
4. What is meant by throwing the gear into "neutral"?

5. What causes the water to cool so rapidly in the radiator?

6. Can you tell the difference between a full-floating and a part-floating axle?

7. What is the purpose of the storage battery in the car?

8. What causes the iron jackets and radiator walls to burst when the water in them freezes?

9. List all the causes you can which might prevent the engine from starting when it is cranked.

10. What is meant by "missing"?

11. Tell how to mend a puncture.

12. What difficulties have you had with your car recently? Describe just what you did to correct the trouble.

13. Find out if possible what the length of life of several cars has been in your community, and the amount of money expended for each. Determine the yearly cost of owning and operating a Ford car. Do the same thing with some other kinds.

14. Mr. A. purchased an automobile for $1,850. He used it six years and sold it to the junk dealer for $40. During the time he had spent $680 for repairs including the cost of tires. What was the average yearly cost of owning the car?

15. Write a composition on one of the following subjects:

Why a Farmer Should Own an Automobile
My Funniest Experience While Motoring
The Automobile Law in My State
My Favorite Car

16. Compare the value of the automobiles owned by the farmers in the community with the value of horses owned by the farmers in the same community.

17. Place a red dot on the community map for each automobile owned.

APPENDIX

The Library

The library is a most important factor in teaching agriculture, particularly when pupils are observing home activities as is suggested in this book. Good books are very desirable and effective tools in the hands of the discriminating teacher who is impelled by a desire to be of service to those of the school community who are outside of school. Good books dealing with agricultural topics will be in demand by the farmers if the school makes them available. The following brief list of books is offered not as a list for the pupils' use only, but as general reading for the farmers in the school community.

Besides books there are thousands of excellent bulletins and circulars dealing with agricultural subjects available to the teacher who wishes to write for them. Teachers should address the United States Department of Agriculture, Washington, D.C., asking for lists of available bulletins, then select the ones which will be of most value to the patrons of the school and place them in the library. Each State Experiment Station and College of Agriculture issues bulletins and circulars which are valuable to the teacher, pupils, and patrons.

Industrial Companies such as the International Harvester Company issue pamphlets and circulars many of which are particularly designed to be used in rural schools. Most of the bulletins, circulars and pamphlets referred to may be secured for little or no cost.

Suggested Reference Books for the Rural School Library

Bailey, L. H.—*Manual of Gardening:* The Macmillan Company (541 pp.)

Benson, O. H., and Betts, G. H.—*Agriculture:* The Bobbs-Merrill Company (44 pp.)

Coffey, W. C.—*Productive Sheep Husbandry:* J. B. Lippincott Company (460 pp.)

Eckles, C. H.—*Dairy Cattle and Milk Production:* The Macmillan Company (342 pp.)

Gehrs, J. H.—*Principles of Agriculture:* The Macmillan Company (594 pp.)

Hopkins, Cyril G.—*The Story of the Soil:* The Gorham Press (350 pp.)

Lewis, H. R.—*Making Money from Hens:* J. B. Lippincott Company (260 pp.)

Lloyd, J. W.—*Productive Gardening:* J. B. Lippincott Company (399 pp.)

Lovejoy, A. J.—*Forty Years Experience of a Practical Hog Man:* Frost Publishing Co., Chicago (170 pp.)

Madden, I. A., and Turner, E. A.—*A Rural Arithmetic:* Houghton Mifflin Company (236 pp.)

Mosier, J. G.—*Soils and Crops:* Rand McNally & Company (394 pp.)

Nolan, A. W.—*A Year in Agriculture:* Row, Peterson & Co. (391 pp.)

PLUMB, C. S.—*Beginnings in Animal Husbandry:* Webb Publishing Co. (390 pp.)
SANFORD, A. H.—*The Story of Agriculture in the United States:* D. C. Heath & Co. (394 pp.)
SPILLMAN, W. J.—*Farm Science:* World Book Company (344 pp.)
STEVENSON, J. A.—*The Project Method of Teaching:* The Macmillan Company (350 pp.)
WOLL, F. W.—*Productive Feeding of Farm Animals:* J. B. Lippincott Company (362 pp.)
WATERS, H. J.—*Essentials of Agriculture:* Ginn and Company (455 pp.)
WAUGH, F. A.—*Landscape Gardening:* J. Wiley & Sons (344 pp.)
WILLIAMS and HILL—*Corn Book for Young Folk:* Ginn and Co. (250 pp.)

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